PRINCIPLES AND METHODS

OF

PHYSICAL EDUCATION AND HYGIENE

BY

W. P. WELPTON, B.Sc.
MASTER OF METHOD IN THE UNIVERSITY OF LEEDS

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PREFACE.

Some apology is needed at this time for presenting to the public a work on physical education. So much has been said and written on the hygienic and medical aspects of school life that it would seem that little more needs to be said. Yet the thought of the present day on these particular aspects of education, thorough as it is in its details and scientific in its outlook, leaves much to be desired. To a great extent it lacks that well-balanced judgment which comes only from viewing school life in all its aspects, intellectual, social, and moral, as well as hygienic and medical.

The theory and practice of education suffer from a multitude of experts regarding the child and the school from a multitude of points of view. Some consider the child only as a thinking machine; others as possessing only a body. A well-balanced theory and practice must look at child life as a whole, at the various bodily activities developing in correlation with mental powers by the child entering fully into the practical duties of life through boyhood and youth to manhood. It is in the practical activities of life—intellectual, social, aesthetic, recreative, utilitarian, or whatever they may be—that the bodily and mental powers act together in the attainment of definite practical ends, and it is through such practical pursuits, varied, advancing in the skill required, and valuable in the ends

attained, that the child will most fully develop all parts of his nature, physical as well as mental, in harmonious relation to each other. From such a point of view the social, moral, intellectual, and physical aspects of education coalesce, and the method and procedure of education present a consistent, harmonious, and well-balanced unity.

Throughout the following work an attempt is made to regard physical education from this single unifying standpoint, so that the physical and the mental aspects of education are brought into harmony. School life is regarded as a whole in which physical and mental training merge in the pursuit of practical duties in which spirit, intelligence, and skill are more than brute strength.

Feeling that a full understanding of the development of skill and physique could not be grasped without a somewhat extensive and deep knowledge of the physical and physiological bases of human activities, I have devoted some space to expounding certain fundamental principles with regard to the energy of life, cell activity, and nervous function. The chapters dealing with these topics may be somewhat difficult to the unscientific reader, and it may be well for him to pass over them lightly on a first reading. I am confident, however, that when he returns to them he will find that a knowledge of these principles gives a deeper understanding of bodily activities and a clearer insight into the method and procedure of physical education.

The opening chapter deals with the historical development of the theory and practice of physical education. This I felt to be the best way of approaching the subject from its human aspect. Modern thought is "heir of all the ages," and we can only fully grasp the tendencies of

the present day by seeing them as the outcome of those of the past. But especially in physical education is a knowledge of its historical development valuable, for life in the past was not so specialised as it is now, and it was viewed more as a whole and less from abstract points of view. Hence there is found in the theory and the practice of past ages a more comprehensive and unifying principle than pervades the educational thought of to-day. Particularly is this the case in the system of physical education of the Ancient Greeks and in the revival of Greek thought during the Renaissance.

An account of the history of physical education, however, needed an author who by the depth and extent of his grasp of the life and education of the different ages could picture and describe the thought and practice of those times with living form and colour. Knowing my shortcomings in this respect, I approached the subject with much hesitation, yet convinced that the historical outlook was the only rational starting point. My difficulty was overcome by my friend and chief, Professor Welton, of the University of Leeds, who with his usual kindness and self-sacrifice volunteered to write the opening chapter. In the wealth of illustration presented, and in the comprehensive grasp of the underlying principles of life and education that pervades a vast diversity of detail, I have found much inspiration, and I cannot too heartily acknowledge my indebtedness to him for his kindness to me and to my readers.

My debt to Professor Welton is yet deeper, for he has read through the whole of the remaining chapters both in manuscript and in proof. It is not too much to say that his thought and inspiration are on every page, directly in

the very many suggestions he has made in reading the chapters, indirectly through my association with him for the past sixteen years, first as my teacher, later as my colleague, and always as a friend to inspire and encourage.

The final chapter on the medical aspect has been very thoroughly revised by Mr. O. T. Williams, M.D., B.Sc., M.R.C.P., Pathologist to the Children's Infirmary, Liverpool, who has made many suggestions and removed several flaws in medical details. Dr. Williams has had much experience of children's ailments, both mental and physical, and as the chapter has met with his approval I feel that although it is but a brief and condensed account of the medical aspect of school life, yet it is an accurate one.

Finally, I must express my thanks to the several publishers who have kindly granted me the use of diagrams. Many of the plates are taken from Dr. Lyster's *School Hygiene* (Univ. Tutorial Press). Figs. 1, 2, and 3 are copied from Wundt's *Principles of Physiological Psychology* (Sonnenschein); Figs. 10 and 10A from Mark's *Educational Theories in England* (Sonnenschein); Fig. 9 from Donaldson's *The Growth of the Brain* (Scott). The diagrams and curves add much to the value of the book, and the kindness of the publishers has saved me much labour.

W. P. W.

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CHAPTER I.

HISTORY OF PHYSICAL EDUCATION.[1]

Early Physical Education.

1. Education in all its forms and aspects has a more or less consciously designed purpose. It always implies that the adult members of a community endeavour to prepare the young to live a more effective life than they would live without such guidance. It is only when a people has advanced far on the way toward civilisation that the educative process is clearly conceived as a whole and its various parts deliberately fitted into each other; and even then this clear insight is reached only by the most thoughtful. With the majority always there is but a vague idea, never definitely formulated in words, of life as a unified whole, and, consequently, of education as a systematised process. Each particular piece of training given to the young is designed to attain a limited end—to give some special aptitude which is seen to be desirable; but there is no enquiry into the relation of these aptitudes to each other, or into the importance of each in the work of life as a whole. Such an enquiry begins to attract men's thoughts only when the pressing needs of existence are easily provided for, so that there is leisure to meditate upon the meaning of life and its ultimate purposes.

[1] By Professor J. Welton, M.A.

Among peoples, then, which have advanced but a little way in the conquest of the physical world and whose existence is a continual struggle to obtain the bare necessaries of physical existence, we shall expect to find attention concentrated on those physical activities—such as hunting and fishing—which directly subserve the bodily life. Life to a savage is little more than eating, drinking, sleeping, and the exertions necessary to ensure a continuance of those desirable modes of existence. Among these exertions will probably be included fighting with neighbouring tribes, and this gives satisfaction also to those pugnacious instincts which are as inherent in human beings as in many of the lower animals. This mode of life determines the education given to the young, which is essentially a training in those forms of physical skill which are of direct importance in the tribal life. Often, indeed, he who is most skilful in them is chosen chief.

But even savages demand amusement for their hours of leisure, however few these may be. Such amusements are always relative to the life they live. The bards relate tales of war and of hunting, and celebrate the more than human prowess of the heroes. The tribe generally joins in the dance, itself a representation of scenes of hunting or of battle. And these dances have usually a religious significance. They are, therefore, bound up with the savage life both on its spiritual and on its material side, and learning the dances is an essential part of the education of the youths.

There is, then, among even the most savage races, deliberate education, or training of the young for life, and this takes a predominantly physical form because life itself is essentially physical. But it must be noted that the training is far from being merely physical, even in its intention. Of course, intimately bound together as are

the mental, moral, and physical sides of our nature, it could never be merely physical in its effects. But the adult savage desires that his son should develop such qualities as bravery, fortitude, perseverance, wiliness, quickness of apprehension, and loyalty to his fellows. As these qualities will be shown in the physical activities of life, so they will be trained through the progressive exercise of those activities. And both song and dance help to cultivate such qualities; the one by raising in imagination a model to be imitated, the other by giving immediate occasion for the feeling thus raised to find expression in forms of activity so closely imitated from those of the actual contests of life, that the feelings aroused by the former would easily pass over into the latter.

This education is, however, only for the boys, as the life activities for which it prepares are those of the manhood of the tribe. The training of the girls is on quite different lines, but is equally practical. To the women fall all forms of labour required about the hut and the settlement of the tribe: in these, then, the girls are trained, and the qualities of character sought are patience, obedience, and industry.

Xenophon's Picture of Persian Education.

2. From such beginnings education will take on more and more elements as the meaning of life is more and more comprehended. But the process will ever be one of development, never one of mere accretion. Always certain qualities of character will be aimed at through certain forms of life activity. We may note a more advanced though still early stage in the largely imaginary account given by Xenophon of the education of the youth of Persia in his historical romance of the early years of Cyrus:

"The boys who attend the schools spend their time in

learning justice," which they do by observing their rulers, who "during most of the day are continually deciding cases amongst them. . . . They teach the boys self-control also, and the sight of their elders living a daily life of self-control contributes greatly to their learning this virtue themselves. They teach them likewise to render obedience to those in authority, and the sight of their elders rendering strict obedience to the authorities contributes greatly to this also. They teach them, too, self-restraint in eating and drinking," both by example and by allowing them only the simplest fare. The boys "learn moreover both to shoot with the bow and to hurl the dart."

Such is the practice of the boys till they are sixteen or seventeen years of age; after this they pass into the ranks of the youth. The training of the latter for ten years is twofold—keeping guard over the city, and hunting, which the Persians esteem highly "as the truest of all trainings for war. For, in fact, it inures them to early rising and to endurance of heat and cold, while it gives them exercise in marches and in running too; they must both use the bow and shoot the dart against a wild beast wherever it falls in their way. Their courage, too, must be often sharpened, whenever any of the strong wild beasts confronts them." Half the youths go hunting at once "many times every month" under the leadership of the king. "The divisions that remain behind, on the other hand, spend their time in practising the other exercises which they learnt as boys, shooting with the bow and hurling the javelin, and are contending all the time with one another in these pursuits. There are likewise public contests in these exercises, and prizes are offered."[1]

Whatever amount of idealisation there may be in this account, there was, doubtless, a substratum of fact, and it

[1] *Cyropaedeia*, I., i., 6-12. Translation by W. H. Balgarnie.

represented the Persian educative aim at its best. In this education we see an intermediate stage between that of savage peoples and the highly organised system prevalent generally throughout Greece, and found in its fullest perfection in Athens. There is full recognition that the training of the young is a matter of public concern, and, consequently, one for public regulation. The training is practical in the highest sense, aiming primarily at the development of a certain type of character, and cultivating those aptitudes through which that type of character would in actual life find scope. There is little trace of intellectual culture either as of value in itself or as a guide to practical conduct. Example and practice are the two means of training. (The girl is still left to the private training of the home.)

Physical Education in Ancient Greece.

3. In Greece the philosophical conception of a unified life first grew up among European peoples, and as a consequence the deliberate consideration of how best to unify education as a training for such a life. Such an idea did not spring up full-grown, but was a gradual development, and always it was in close touch with the national religion.

Religious Games in Homer.

In the Homeric poems life is still preponderatingly physical, and it is in them that we have the first account of those religious games and athletic contests which played so large a part in Hellenic life, and so directly determined the form of physical training given to Greek youths. The contests described most vividly and at considerable length by Homer are summed up in the reminiscences of Nestor:

> "In the boxing match
> I took the prize from Clytomedes, son
> Of Enops, and in wrestling overcame

> Ancaeus, the Pleuronian, who rose up
> Against me. In the foot race I outstripped,
> Fleet as he was, Iphiclus, and beyond
> Phyleus and Polydore I threw the spear.
> Only the sons of Actor won the race
> Against me with their chariot, and they won
> Through force of numbers." [1]

The Olympic Games.

Such games added dignity to every important ceremony in ancient Hellas, and not much later than the supposed date of the Trojan War they were held periodically at several centres in Greece. To each was assigned a mythical origin connected with the presiding god, and always their religious character was prominent. Such games were the Delphian, the Isthmian, and the Nemean.

But by far the most renowned were the Olympic Games. So important were these that they were made the basis of Greek chronology. The space of four years between successive games was called an Olympiad, and the first Olympiad was the period following B.C. 776, from which time the names of the Olympic victors were enrolled in the public registers. So Greek historians recorded events which to us seem of infinitely greater importance by reference to the winners of these contests. For example, Thucydides refers to an important event in the Peloponnesian War as occurring in "that Olympiad wherein Dorieus of Rhodes was the second time victor." [2] And in such an important State document as the Articles of the famous League between the Athenians and the Argives there are two references to these games: "This oath shall be renewed by the Athenians, who shall go to Elis, and to Mantinea, and to Argos thirty days before the Olympian

[1] *Iliad*, Book XXIII., ll. 632-640. Translation by W. C. Bryant.
[2] Book III.

Games. . . . And at the Olympian Games now at hand, there shall be erected jointly by [the States forming the league] a brazen pillar in Olympia" [recording "the articles of this league and peace, and the oath "].[1]

Olympia was thus a kind of centre of national life where important records of events of interest to more than one State were preserved. This character was emphasised by the fact that during the month given up to the games a sacred armistice was established throughout Hellas, and Greeks from all the States flocked to Olympia as competitors or as spectators. The games were held in honour of the Olympian Zeus, to whom, as to the other gods of Hellas, the display of the beauty, strength, agility, and skill of the human body was held to be specially pleasing. They included all the modes of athletic contest enumerated in Homer, with several later developments. Thus there were all forms of running and leaping, of racing on horseback and in chariots, of throwing javelins and quoits, of boxing and wrestling, and the "Pancratium," a combination of the two latter of so severe a character that it was judged unfit for boys. The "Pentathlon" was a five-fold contest in leaping, hurling the javelin, racing on foot, throwing the quoit, and wrestling, the exercises being taken in that order, and the weaker competitors being eliminated at each step, so that in the wrestling only two engaged, and the result decided the whole contest.

The victor in the various games received from the judges a symbolic wreath cut from the sacred olive-grove of Zeus, but this was far from being his only reward. His native city heaped honours upon him, poets and orators celebrated his praises, statues were erected to him not only at home, but in the sacred groves of Olympia, amid other

[1] Thucydides, Book V.

records of events of general Hellenic importance. So, as Lucian says, "the prizes are not of small account, nor is the praise of the spectators, nor that the victor becomes the most honoured of the Greeks, be pointed at with the finger by the multitude, be regarded as the noblest of equals in rank."[1] It is not surprising, then, to read in Herodotus: "Callias, indeed, deserves to be frequently mentioned by everyone; as well for his zeal, which I before mentioned, in restoring the liberty of his country, as for the actions he performed at the Olympian exercises. He won the race with a single horse, and was second in the quadrijugal course."[2] Distinction in the games was, we see, esteemed as highly as the greatest political services.

In the days of Greek freedom and greatness the competitors were all free-born youths of Hellas, unstained by sin against the gods or crime against the State, and carefully trained in the gymnasia for the contests in which they were to engage. But the excessive rewards heaped upon the victors led later to the growth of a class of professional athletes, and so to the gradual degradation of the games from being one of the highest expressions of national life to mere gladiatorial spectacles. This degradation was not finally accomplished till after the conquest of Greece by the Romans, though it had begun several centuries earlier. But at length none but professional athletes competed, and they drawn from any and every barbarian nation. So the games had long ceased to fulfil a

[1] *Anacharsis*, translated by Lowrey. Though Lucian wrote towards the end of the second century after Christ, when Greek life and education had lost their vitality, yet in this dialogue between Solon, the great Athenian lawyer, and the Scythian, Anarcharsis, he puts into the mouth of Solon the old Greek views on physical training.

[2] *History*, VI., 122.

vital function in Greek life when they were suppressed in A.D. 394 by the Emperor Theodosius.

In the earlier days, however, their influence on Greek life and character was of the utmost importance. The friendly gathering at these contests of men from every part of Hellas, dominated by the same interests and engaging in the same religious observances, did much to break down the walls of isolation between the different Greek races which the physical configuration of Hellas and the political organisation into small and independent city-states did so much to build up.

Beyond all this, the games were of the first importance in determining the Greek conception of the perfect life, and so in influencing Greek education. As Lucian puts it: "We have established these exercises . . . not simply that the young men be able to take prizes in the contests, for but very few from the whole number procure the rewards. But we have gained, however, from this practice a far greater good to the State and to the individuals themselves. For let me remind you there is a common contest of another sort set for all good citizens. Its crown is woven not from pine, nor from the branch of the olive, nor from parsley; but whoever has a part in it sustains human happiness, and, I may say furthermore, he upholds the liberty of each private individual and that of the common Fatherland, he preserves wealth, honour, the joys of ancestral festivals, the safety of his family, and, in fact, he vouchsafes all those blessings which we would pray the gods to bestow upon us. All these delightful objects have been woven in that garland of which I speak and are the result of that contest towards which these exercises and these labours lead."[1]

No plainer statement could be made of the position that the ultimate end sought was the development of a certain

[1] *Op. cit.*

type of character, and that this could be attained best through engaging the young in certain forms of those physical contests to which boys and youths are naturally prone. It is not meant that this more remote educative aim was present to the minds of the youths themselves. By no means. This would have vitiated the whole system. Then, as now, boys and youths must enter into the contests for the sake of the contests themselves and with a single eye to victory therein, or the full absorption of energy into the work in hand is wanting, and as a consequence the essential end of doing what is to be done with all one's might is not secured. But it is the very essence of a really educative process that an end not apprehended by him who is being educated should guide the efforts of those who are educating him.

Physical Education at Sparta.

Nowhere in Hellas was this conception of education through physical exercise carried out so exclusively as at Sparta. The Spartan ideal of human worth was essentially military. The town had no protective walls, for it was held that the true bulwarks of a city should be the breasts of its citizens. The whole training of the youth of Sparta was, then, directed to developing hardihood of character and hardness of body.

Only those babies that gave promise of strength were allowed to live, the others were cast out on the mountains to die of cold and neglect. At seven years of age every boy was sent to the public training school, where he was lodged hardly, clad in only one thin garment, and given insufficient food that he might learn to forage successfully in war by stealing without detection what he needed in peace. He was constantly trained in gymnastic exercises, and, as he grew older, in those of war. His only intellectual education was music, and that of a stirring,

warlike nature. At the age of twenty he went to military barracks, and became essentially a soldier, and throughout life his first duty was to the State.

Not content with the fortitude and hardihood which such a training would naturally produce, the Spartans made occasions for practice in bearing pain. The boys were beaten yearly before the altar of Artemis till their blood soaked the ground. Lucian gives us a picture of these customs which is valuable in showing how a training, which, in most of its essential features, runs counter to the love of ease and pleasure which a modern is apt to think one of the most important springs of human conduct, may yet be gloried in when it expresses as thoroughly as did that of Sparta the national ideal. In the *Anacharsis* Solon is made to say:

"If ever you come to Lacedaemon, bear in mind not to ridicule, nor to think that they labour to no purpose. Either if while at ball in the theatre they come to blows and strike down one another, or if when they come into an open space surrounded by water they divide lines and work against one another, even while naked, the deeds of war, until one party throws the other out of the inclosing line, until the party of Heracles thrusts into the water that of Lycurgus, or the reverse, you will learn that this is a signal for peace, and no one would strike after that. But especially guard lest you ridicule if you see young men beaten upon a trestle and flowing in blood, while fathers and mothers stand hard by, and are not undone by that which occurs, but, rather, if their children do not endure the blows, they chide, and they pray their offspring to be adequate for their toil as long as possible, and to be patient under suffering. Many, indeed, in the past, because they have not deemed it honourable while still alive and under the eyes of their relatives to become weary and to yield to their bodies, have died in the

contest. You will see the statues of such heroes set up by Sparta and their names publicly honoured.

"When you see these customs, neither suspect that they are mad nor say that they endure suffering without adequate cause, nor that a tyrant compels them, nor that their enemies enforce this upon them. Lycurgus, their lawgiver, will speak many rational words in behalf of their customs; how from a plain understanding of the necessities of the case he chastises the youth; how he is no enemy; that he does this not from hatred, nor does he institute it to waste to no purpose the youthful energy of the body politic, but he does this because he considers that those who shall save their fatherland must be most patient and superior to all suffering."

We could not have a more explicit statement of the actual attainment of a moral end definitely conceived by the educators, through means deliberately adopted as calculated to attain that end and accepted willingly by the young through the influence of the national sentiment.

In Sparta, too, the girls received a full course of physical training, in order that both in physical strength and in hardihood of character they might become fitted to be the mothers of soldiers.

Aim of Education at Athens.

Nowhere else in Hellas was so single an eye kept upon one side of life and one type of character. Elsewhere, and especially at Athens, a wider and more adequate conception of life as a whole became more and more dominant, till in the heyday of Athenian greatness men in general reached a more complete view of the relations of the spiritual and physical aspects of life, and embodied that view in a more harmonious scheme of education than has been seen elsewhere. This education was a combination of literary and musical and artistic culture, called generically 'Music,' and of physical training, known as 'Gymnastic.'

No doubt the first answer given by an Athenian citizen to a question as to the functions of these two would have been, as Plato puts it, "Gymnastic for the body and music for the soul."[1] But just as an English father of to-day, though he would think first of the physical effect of games on his son, yet would grant at once to an enquirer that he wishes and expects him to grow in pluck, sportsmanship, and other manly virtues through his games, so an Athenian would quite have accepted the argument by which Plato leads up to the position that "neither are the two arts of music and gymnastic really designed, as is often supposed, the one for the training of the soul, the other for the training of the body," but "that the teachers of both have in view chiefly the improvement of the soul."[2]

On the evils of excessive devotion to each Plato also voices common Athenian opinion: "The mere athlete becomes too much of a savage, and the mere musician is melted and softened beyond what is good for him."[3] The true aim of education is, therefore, a judicious blending of the two, "and he who mingles music with gymnastic in the fairest proportions, and best attempers them to the soul, may be rightly called the true musician and harmonist. . . . Such are our principles of nurture and education."[4]

The actual education in Athens was free from State control. Anciently the laws had laid down regulations for the conduct of schools and for securing the attendance of boys at them. But the Athenian father did more for his son than the law commanded, and consequently the State regulations fell into desuetude. Plato and Aristotle objected to this practical freedom as giving insufficient security for the maintenance of the national type of

[1] *Rep.* 376, Jowett's translation.

[2] *Rep.* 410. [3] *Ibid.* [4] *Ibid.*, 412.

character, but their objections were really retrograde and had no practical result.

Education in Early Youth.

Till about the age of seven the Athenian boy was at home, engaging in those childish sports and occupations which seem to be found in every age and in every country. About the age of seven he began to attend school, where the poetical and heroic literature of Greece supplied the material for his culture. But it was not till the age of twelve or thirteen that systematic physical training began. Before this his physical development had been left to free play, which was, of course, only a negative educative proceeding on the part of his guardians, but not the less wise on that account.

An Athenian School Day.

At about thirteen the boy attended also at a school of physical training, called a palaestra, and thereafter till about the age of eighteen he divided his day pretty evenly between the two schools; or, perhaps, between three, as literature and music were commonly taught in separate establishments. Lucian gives us a charming picture of the boy's day: "He gets up at dawn, washes the sleep from his eyes, and puts on his cloak. Then he goes out from his father's house, with his eyes fixed upon the ground, not looking at any one who meets him. Behind him follow attendants and paidagogoi, bearing in their hands the implements of virtue, writing-tablets or books containing the great deeds of old, or, if he is going to a music school, his well-tuned lyre.

"When he has laboured diligently at intellectual studies, and his mind is sated with the benefits of the school curriculum, he exercises his body in liberal pursuits, riding or hurling the javelin or spear. Then the wrestling-school with its sleek, oiled pupils, labours under the mid-day sun, and sweats in the regular athletic contests. Then a bath, not too prolonged; then a meal, not too large, in view of

afternoon school. For the schoolmasters are waiting for him again, and the books which openly or by allegory teach him who was a great hero, who was a lover of justice and purity. With the contemplation of such virtues he waters the garden of his young soul. When evening sets a limit to his work, he pays the necessary tribute to his stomach and retires to rest, to sleep sweetly after his busy day."[1]

Physical Training in Athens.

It is only with the physical side of this education that we are concerned, and it should be noted that in addition to the formal and systematic training in the wrestling-school, or palaestra, it included exercise uncontrolled by the master of gymnastics, or, in other words, free play. The inclusion of this essential element of physical education in the Athenian scheme seems to have been frequently overlooked.

Similar plans of education prevailed generally throughout Hellas except in the States modelled upon Sparta. In every city was at least one gymnasium, in every hamlet at least a palaestra; and in these boys, youths, and men followed with assiduity the exercises which entered into the Olympic and other national games.

Gymnasia.

In Athens and some other of the larger cities the gymnasia were public institutions of considerable size, and contained not only exercise grounds but porticoes and other buildings and shady groves in which the citizens could walk and talk. For the gymnasia became, as has been aptly said, "the centre-points of Greek life." In them, besides the youths and young men engaged in the exercises, were to be found philosophers expounding their systems, rhetoricians teaching their art, citizens discussing politics or exchanging the gossip of the day. No women, of course, were present, but every

[1] *Loves*, 44-45; quoted by Freeman, *Schools of Hellas*, pp. 79-80.

occupation which filled the abundant leisure of the Athenian citizen of means was there represented.

Palaestrae.

In such a varied concourse it would not have been possible to keep the attention of young lads fixed on the exercises they had to learn, and so, though boys at times were to be found in the Athenian gymnasia, yet their physical education was carried on in the palaestrae, or open-air wrestling-schools to which reference has already been made. Here it was under the superintendence of an instructor called a paedotribe, a word meaning literally "boy-rubber," and so suggesting the important part rubbing the skin with oil and dust played in Greek physical training. The exercises were based on those practised in the gymnasia, just as the latter were determined by the contests of the national games. Of course they were graduated both in amount and in severity, and the utmost care was taken to adapt each to the strength of the individual. All were carefully watched by the paedotribe or his assistant, who checked any ungainly or ineffective motions. Frequently, to secure greater rhythm of movement, some of the exercises were performed to the sound of the flute. This was especially the case with dancing, to which as a means of developing a graceful carriage and a modest demeanour the Athenians attached considerable importance.

All exercises were performed naked, whether in palaestra, in gymnasium, or in the national games. Thucydides tells us that the Spartans "were the first that, when they were to contend in the Olympic games, stripped themselves naked, and anointed their bodies with ointment: whereas, in ancient times, the champions did also in the Olympic games use breeches; nor is it many years since this custom ceased."[1] Among the advantages claimed for this custom

[1] *History*, I. 6. Thucydides wrote in the fifth century B.C.

was that the trainer could the better see the action of the muscles in the trained. It appealed moreover to the passionate love of the physical beauty of the youthful form which was so marked a Greek characteristic.

Greek Exercises.

On the careful adaptation of means to an ultimate aim at once moral and practical in the physical training Lucian is quite explicit: "We develop their bodies somewhat as follows: We strip them of their clothing; as I remarked before, they are no longer delicate, and yet are not sufficiently compact for their life work. We consider that the first step is to accustom them to the air; to render their bodies inured to each season, that neither with the heat they may be troubled nor may become exhausted from the frost. Next, we anoint their bodies with oil to soften them and to make them more sinewy. . . . After this, we devise various kinds of gymnastic exercises and place directors over each. We teach one to box and another the pancratian contest. We do this that they may become accustomed to endure hardships manfully and at the same time to avoid blows, and that not from fear of wounds they be turned back from their purpose.

"This discipline works out in them two very important qualities that are of great value to us. They are prepared to be courageous in danger and to take little account of their bodies, but above all their bodies become stout and capable of endurance. Further, those who catch falls in wrestling learn to fall with safety, easily to rise again, to push, to embrace, to twist, to be able to endure strangling, and to send their antagonists into the air; nor do those who exercise regard this part as useless, but without hesitation they grasp the first strong man they meet, even the very strongest. In this way their bodies are hardened to suffering and by constant toil become more robust. . . .

"Our young men . . . are tinged a dusky red by the sun, are masculine, have much spirit, show great zeal and manly courage, and furthermore enjoy excellent health. . . . You may depend upon it, only after long labour would he who has been subject to this training sweat, and very rarely would he show signs of weakness. . . . So likewise, if disease and fatigue should unexpectedly attack such a body as our young men possess, they could neither readily dishonour it nor easily conquer it. . . . In fact, previous toil and pain have produced no loss of strength, but an increase, and that strength by being rekindled has become still greater.

"We train our young men to run also; we accustom them to endurance in a long race and encourage them to make a short distance in the quickest possible time. The course is not formed upon firm ground that will resist, but in the deep sand, where it is easy neither to step with firmness nor to lean forward, and where the foot is burdened with the yielding path. In addition to this, we exercise them in leaping ditches, if thought necessary, or any other impediments, even with their hands filled with leaden weights. They contest, further, in throwing the javelin to a long distance. Now, I believe you noticed something else in the gymnasium. The object was of brass and was rounded somewhat like a small shield, but it was without either handle or band. You examined it as it lay in the court. You thought it heavy, and from its smoothness hard to grasp. That, too, they raise in the air and throw to as great a distance as possible. Him who, by throwing the plate [*i.e.* the discus or quoit] the farthest, surpasses the others we honour. This exercise strengthens their shoulders and puts sinews in their toes.

"Now, my friend, if you will listen, I shall explain why the mud and the dust, which at first seemed to you very ridiculous, were thrown down. In the first place, that the

fall of the young men may not be hard, but that upon a soft surface they may be thrown with safety. Then it is necessary that the slipperiness of men sweating in the mud become greater—a slipperiness which you likened to that of eels. We regard this also neither useless nor ridiculous. Whenever the contestants are compelled in this condition to seize one another with the vigour of antagonists and to hold those who are slipping from them, this effort lends not a little to the development of their strength and sinew. To grasp a person that is sweating in mud and oil, and to throw him while he is slipping hastily from your hands, is not a small thing to do. And, as I said before, all these practices are especially useful in time of war against our enemies; for instance, if it be necessary at any time to catch a wounded friend and at once to bear him away, or to come upon an enemy unawares, to grasp him while surprised, and to secure him. That, while anticipating harder trials, our young men may bear smaller tasks with far greater contentment, we train them somewhat to excess.

"Then, on the contrary, we regard the dust of service in preventing them from slipping their embrace. For while they were training in the mud to hold the one who tried to escape by reason of his slipperiness, they also became accustomed to slip from the hands of those who seized them, and that, too, even when cornered. And the dust likewise seems to hold in check the perspiration and to stop an excessive or sudden flow; it thus husbands their strength for a longer time, and prevents injury from the winds that might blow upon their bodies while exposed and weakened. Furthermore, it scours off the filth also, and makes the man more glossy. . . .

"These are some of the reasons why we subject our young men to exercise. We expect them to become a noble guard to our body politic, and that through their protection

we shall live in the enjoyment of liberty. Should our enemies invade our territory, these will conquer them. In fact, to such an extent are they now a fear to our neighbours that most of the States are in awe of us and pay tribute. In time of peace we can manage much better those who are elated by nothing disgraceful. Nor are our young men thus turned from idleness to wantonness, but in such pursuits as these they wear away their leisure. Finally, whenever we can say that our youth, both in peace and in war, are fitted to do the noblest deeds, that they appear zealous for our highest honour, then we possess that which I spoke of as the common weal, as the happy culmination of our civil prosperity."[1]

We have quoted at such length because Lucian gives us so vivid a picture of the strenuousness of the Greek training, and at the same time shows us how carefully thought out it was even in its smallest details. Although the Greeks had no scientific knowledge of physiology, yet by careful observation of the effects of this or that exercise they produced a general system that has never on the whole been surpassed, while in the thoroughness with which they recognised physical training as an essential part of education they have never yet been equalled. Our future path will lead us to no such harmonious system.

The Ephebei.

The gymnastic system was indirectly a training for war, and, as Lucian urges, the best training, because it inured the body to fatigue, gave it the power of endurance, and developed spirit and persistence. Training for war by actual combats with arms—as, for example, the mediaeval tournaments—he condemns. "Away with your desire to try our young men in armour and to see them wounded. It is savage, terribly cruel, and, furthermore, utterly useless to slay our bravest

[1] *Anacharsis.*

and noblest men, any one of whom we might better use against our enemies."[1]

However, the necessity of accustoming the future citizen soldiers to military life and to military discipline was recognised. At Athens, as in Greek states generally, the young men, from about the age of eighteen to that of twenty, lived in garrison and performed the duties of frontier guards, having first taken a solemn oath of allegiance to their country. That at Athens was as follows:—"I will not disgrace my sacred weapons nor desert the comrade who is placed by my side. I will fight for things holy and things profane, whether I am alone or with others. I will hand on my fatherland greater and better than I found it. I will hearken to the magistrates, and obey the existing laws and those hereafter established by the people. I will not consent unto any that destroys or disobeys the constitution, but will prevent him, whether I am alone or with others. I will honour the temples and the religion which my forefathers established. So help me Aglauros, Enualios, Ares, Zeus, Thallo, Auxo, Hegemone."[2]

These 'ephebei,' as the young men were called, were under the direct supervision of the State, and special officers were placed in charge of them. In the earlier days their training was nearly entirely physical and military, but with the growth of intellectual interests in Athens a cultural element was introduced, and this grew continually larger. After the loss of Athenian independence the military organisation remained only in form, and the ephebei spent their time in studying rhetoric, philosophy, and other branches of knowledge. Finally, by amalgamation with the established philosophical schools, the

[1] *Anacharsis.*

[2] Translation from Freeman's *Schools of Hellas*, p. 211.

ephebic college became merged into the university of Athens.

Education of Athenian Girls.

It appears then that the physical education of boys in Ancient Greece was, at its best, singularly complete, admirably adapted to the state of life there and then to be lived, and designed to co-operate with other parts of education so that the whole process might develop the Hellenic ideal of a man, self-reliant, loyal to his fatherland, and well-proportioned and harmonious both in body and in mind. When we turn to the training of girls, however, we find a very different system. The Athenian woman was essentially a house-wife who spent her time at home. Nor was she to any great extent a companion to her husband, who spent by far the greater part of his life abroad, or a guide to her sons, who after the age of seven were removed from her care so far as their education was concerned and were also but little at home during the day. Usually married early, her full training in household duties was regarded as the task of her husband, who thus had a better chance of moulding her to his wishes.

We may gather an impression of the usual custom from the description of his wife given by Ischomachus in the *Œconomicus* of Xenophon. "What could she have learnt, Socrates, he said, when I received her? for she came to me when not yet fifteen years old, and during the time preceding that had lived under strict surveillance, in order that she might see as little as possible, hear as little as possible, and speak as little as possible. For do you not think that one must be content if she came merely knowing how to make a garment if she had wool given her, and having observed how the spinning tasks are apportioned to handmaids? For certainly, he added, as to what concerns the appetite, Socrates, she had been thoroughly well brought

up, and that seems to me to be the chief point of instruction both for a man and for a woman."[1]

Again we see how the conception of life—in this case narrow—dictated the form of education.

Decline of Greek Education.

With the loss of Hellenic independence came a sterilisation of Hellenic education. Life had been so bound up with public affairs that when the management of these was taken out of the hands of the citizens, thought largely lost its content, and oratory its purpose. Thus a formal rhetoric usurped the place of living thought, and the way of saying a thing became of more value than the thing said. Similarly, on the physical side, the real aim and purpose was devitalised. No longer a preparation for the defence of the fatherland, the gymnastic exercises became more and more of the nature of recreation, and thus lost their strenuousness and with it their value as means of training character. They occupied, too, less and less of the time given to education, especially after the years of boyhood and early youth. The ephebei devoted themselves exclusively to rhetoric and cognate arts, and sought recreation more and more in sedentary amusements such as drinking and gaming. The national games were, then, bound to decay, as we have seen they did. In a word, with the loss of real national life, the national education ceased to have a distinct object, and became effete, even though it showed much intellectual brilliancy and sparkle.

Physical Education in Ancient Rome.

4. In the early Roman Republic the education of the children was entirely domestic, with a definitely moral and very narrowly practical aim. On the physical side it was essentially a preparation for the life of a soldier, and included running, wrestling, swimming, throwing the

[1] *Œconomicus*, VII.; translation by Hayes.

spear, and horsemanship. The adult citizens were trained in military evolutions in the Campus Martius, and after the exercises would swim across the Tiber to free themselves from dust and sweat. A picture of this earlier education is given by Plutarch in his account of Cato. "Not only did he show him, too, how to throw a dart, to fight in armour, and to ride, but to box also and to endure both heat and cold, and to swim over the most rapid and rough rivers."[1]

When the Romans conquered the Macedonian Empire they came into very direct contact with Greek culture and education, both, however, as we have said, in a decadent form. But even so it was too idealistic and aesthetic in intention—especially on the physical side—to be assimilated perfectly by the practical Roman mind.

Aemilius Paulus, the conqueror of Macedonia, is said to have been among the first to adopt for his son a form of physical training not purely military, and to entrust his intellectual education to learned Greeks. The fashion spread rapidly, and higher instruction in Rome became essentially Greek both in its content and in its rhetorical form. But the system of gymnastic training was never fully acclimatised. It is true that small private gymnasia were erected by some of the wealthier citizens, and that a public gymnasium was established by Nero, but the physical training had lost its vital purpose, and was little more than recreation, with none of the strenuousness, and consequently with none of the moral value, which had been so characteristic of it in Hellas. Indeed, in Rome the gymnasium was a mere adjunct to the baths, in which the Romans delighted to pass their time in an agreeable idleness.

[1] Quoted by Wilkins: *Roman Education*, p. 14.

The Roman boys doubtless had sports, especially various games with balls, which promoted their physical development and cultivated agility, but as time went on physical training with any really serious purpose fell more and more into the background, and the idea of recreation reigned supreme. With growing luxury, too, recreation was increasingly sought by those beyond boyhood in more exciting, if less healthful, forms of amusement, such as dicing and other modes of gambling.

Dancing, which had been a serious part of education among the Greeks, was by the Romans looked upon as unworthy the children of a free citizen. A passage from a speech of Scipio, delivered in B.C. 133, makes this clear. "They are taught unseemly tricks when they go with dancing boys and a lute and psaltery to the actors' training school. They learn to sing songs which our ancestors would have regarded as a disgrace to free-born lads. Free-born boys and girls, I say, go to a dancing school with professional dancers. When any one told me this, I could not get myself to believe that noblemen taught their children such things: but I was taken to the dancing school, and there upon my word I saw more than fifty boys and girls: among them one—and this made me more sorry for my country than anything—a boy of good family, the son of a candidate for office, not less than twelve years of age, dancing with castanets a dance which a vile slave-boy could not have danced without discredit."[1]

The Greek games, too, were in a sense imitated in their outword form, but their inward spirit was always absent. In Rome they were mere shows in which hired gladiators or prisoners engaged in contests, often to the death, with each other and with wild beasts, for the entertainment

[1] Quoted by Wilkins: *Roman Education*, pp. 34-35.

of a populace growing ever more callous and more brutalised.

Further, under the autocratic tyranny of the later Empire even this artificial and devitalised education borrowed from Greece became more and more empty of any serious purpose; more and more on the intellectual side the cultivation of mere rhetorical display, while on the physical side it was nothing but amusement. The want of purpose in life and the want of purpose in education reacted upon each other, and in regarding the conjoint process we cease to wonder at the decline and fall of the great Roman Empire.

Physical Education in the Middle Ages.

5. The external instruments of this fall were the barbarian races which for several centuries made irruptions and settlements in various provinces of the Empire. These peoples were generally in a low stage of civilisation—indeed, some were not far removed from the lowest savagery.

The Barbarians.

An old Roman soldier, Ammianus Marcellinus, towards the end of the fourth century thus described the Huns:—"The people called Huns, barely mentioned in ancient records, live beyond the Sea of Azof, on the border of the Frozen Ocean, and are a race savage beyond all parallel. At the very moment of birth the cheeks of their infant children are deeply marked by an iron, in order that the hair, instead of growing at the proper season on their faces, may be hindered by the scars; accordingly the Huns grow up without beards and without any beauty. They all have closely knit and strong limbs and plump necks; they are of great size, and low legged, so that you might fancy them two-legged beasts, or the stout figures which are hewn out in a rude manner with an axe on the posts at the end of bridges.

"They are certainly in the shape of men, however uncouth, and are so hardy that they neither require fire nor well-flavoured food, but live on the roots of such herbs as they get in the fields, or on the half-raw flesh of any animal, which they merely warm rapidly by placing it between their own thighs and the backs of their horses.

"They never shelter themselves under roofed houses, but avoid them, as people ordinarily avoid sepulchres, as things not fit for common use. Nor is there even to be found among them a cabin thatched with reeds; but they wander about, roaming over the mountains and the woods, and accustom themselves to bear frost and hunger and thirst from their very cradles. . . .

"There is not a person in the whole nation who cannot remain on his horse day and night. On horseback they buy and sell, they take their meat and drink, and there they recline on the narrow neck of their steed, and yield to sleep so deep as to indulge in every variety of dream. . . .

"None of them plough, or even touch a plough handle, for they have no settled abode, but are homeless and lawless, perpetually wandering in their waggons, which they make their homes."[1]

But soon, through contact with the Roman civilisation, they were greatly changed, and adopted some of the outward forms of a more refined life. The same was true, in varying degrees, of the Germanic tribes that poured into the Empire from northern Europe. But wherever they went they carried fire and desolation with them. St. Jerome, at the beginning of the fifth century, tells us: "Nations innumerable and most savage have invaded all Gaul. . . . Mayence, formerly so noble a city, has been taken and ruined, and in the church many thousands of

[1] Quoted by Robinson: *Readings in European History*, vol. i., pp. 35-36.

men have been massacred. Worms has been destroyed after a long siege. Rheims, that powerful city, Amiens, Arras, Speyer, Strasburg—all have seen their citizens led away captive into Germany. Aquitaine and the provinces of Lyons and Narbonne, all save a few towns, have been depopulated; and these the sword threatens without, while hunger ravages within. . . . Spain, even, is in daily terror lest it perish, remembering the invasion of the Cimbri; and whatsoever the other provinces have suffered once, they continue to suffer in their fear."[1]

Among such peoples, and in such times, it is obvious that the training of the boys would be essentially in physical hardihood and endurance and largely given through early participation in the life of war and plunder led by the tribe.

Sports in the Middle Ages.

Even when, in the course of centuries, the barbarians had settled down more or less thickly in the various parts of the Empire, and had adopted the culture and religion, and in many cases the speech of those they had conquered, this ideal of hardy manhood, and of the need of a training in youth adapted to secure it, remained. So throughout the Middle Ages life was largely an outdoor life, and all kinds of manly sports were the delight of men as well as of children. In our own land hunting, fishing, and hawking were favourite amusements. Boys were taught archery and slinging, and were encouraged to practise exercises, such as running, leaping, wrestling, and swimming, which developed strength, agility, and power of endurance.

Nor was this thought merely a matter of private interest. Especially was archery enjoined by authority, and it was part of the duty of the magistrates to be present at the

[1] Quoted by Robinson: *op. cit.*, p. 44.

sports held on village green or at the town butts on Sundays and holy days, and to see that shooting with bow and arrow was not neglected. Apparently less serious games were more popular, for in 1363 the king, Edward III., wrote to the lord-lieutenant of Kent:—

Official Encouragement of Archery.

"Whereas the people of our realm, gentle and simple alike, were wont formerly in their games to practise skill in archery,—whence, by the help of God, it is well known that high honour and advantage came into our realm, and no mean advantage to ourselves in our feats of war,—and that now, the said skill in archery having fallen almost wholly into disrepute, our people give themselves up to the throwing of stones and of wood and of iron; and some to handball and football and hockey; and to coursing and cock-fighting; and some even to other unseemly sports that be less useful and manly; whereby our realm—which God forbid—will soon, as it appeareth, be stripped of archers:

"We, wishing that a fitting remedy be found in this matter, do hereby command you that, in all places in your county, liberties or no liberties, wheresoever you shall see fit, you have proclamation made to this effect: that every man in the same county, sobeit he be able-bodied, shall, upon holidays, make use, in his games, of bows and arrows, and learn and practise archery:

"Moreover, that you prohibit all and sundry in our name from such stone, wood, and iron throwing; handball, football, or hockey; coursing and cock-fighting; or other idle games; under penalty of imprisonment."[1]

In the next reign (1388) it was enacted that "Servants and labourers shall have bows and arrows, and use the same the Sundays and holydays, and leave all playing at

[1] Rymer: *Foedera*, iii. 704. Quoted in *English History from Original Sources*, 1307-1399, Part II., pp. 10-11.

tennis and football and other games called coits, dice, casting of the stone, skittles, and other such importune games." In every village two acres of land near the church were reserved for this purpose, and long after the fourteenth century it was held to be by custom unlawful for the lord of the manor to plough them or in any other way to break them up.

The Church and Physical Education.

Physical training was evidently conceived by the authorities in the narrowest practical way as a direct training for war, and by the populace as essentially recreative. This latter was, on the whole, the practical doctrine of the Church, though always with a tendency to limit the amount of recreation considered necessary. In the earliest ages of Christianity life was generally viewed from an ascetic standpoint. The force of bodily appetites was fully recognised, the effects of unbridled licence were only too visible in the corrupt society of the later Empire, and the great aim of the Christian, who though in the world was not of it, was to "keep under the body and bring it into subjection." The highest ideal of life, then, was one that aimed at the negation of all bodily delights and the voluntary infliction of all kinds of bodily vexations. The extravagances of some of the earlier hermits and monks exemplified this in its most extreme form.

The adoption of Christianity as the official religion of the Roman Empire, however, wrought a great change. Multitudes joined the Church without any deep conviction of the truth of her doctrines or any real attachment to her views of life. An ideal which had seemed attainable to a persecuted and zealous few was unsuited as a model for the very moderately enthusiastic many. Moreover, the Church soon had to face the flood of barbarism which flowed over the Empire, and was, perforce, content if she induced her rough converts to lead a moderately decent life, and to

accept as the rule of conduct the prohibition of open and notorious evil-doing. A kind of two-fold conception of life was the inevitable outcome of the conditions of the time. For clergy, monks, and nuns, who devoted their lives to religion, the Church laid down, as the rule of life, a modified form of asceticism, in which austerities were commended, though solely for the sake of spiritual advancement. For the mass of the people she showed toleration of a much more material and much less spiritual life, content if they accepted her teaching, and gave heed to her admonitions.

For the former the training had an entirely religious aim, and an essential part of it was that negative but very real form of physical education which consists in the denial of bodily appetite, the avoidance of bodily ease, and the infliction of bodily austerities. But this ascetic training was enforced upon none save those who voluntarily sought the 'religious' life, and even among them the only compulsory rule was mild, though freedom was given for individual attempts to attain greater sanctity through increased physical privations.

For the latter the Church undertook the teaching of religion, morals, and secular learning, and to the scholars in her schools she gave times of leisure for recreation. But in the nature of the recreation she did not interfere, so long as it was innocent and did not encroach on the time apportioned to study. For example, the early statutes of the colleges at Oxford and Cambridge contain nothing which encourages or authorises physical exercises, but much intended to restrict them. Even "playing with a ball or a bat" is at times forbidden as an "insolent" game. Doubtless many of the students in practice indulged in hawking and other forbidden amusements with all the greater zest on account of such prohibitions. Nothing

could restrain the exuberant vitality of the Middle Ages, with its love of outdoor sports, the gratification of which was easy on account of the smallness of the towns and the accessibility of open country and of forest.

Punishments in Mediaeval Schools.

In one way, indeed, mediaeval schools, like those both in ancient Rome and many in more modern times, gave a real physical training, though on the scholar's part it was passive in its character. The severity and frequency of the punishments were certainly calculated to cultivate fortitude in bearing pain. Of course, this severity was, much more in the Middle Ages than in later times, a reflex of the roughness of manners generally; but it was deliberately adopted even by the most kindly teachers of children as designed to advance their moral good. "Spare the rod and spoil the child" was a universally accepted maxim—was it not the advice of Solomon, the wisest of men? Nor do the boys seem to have regarded these punishments as cruelties. They all came in the day's work, and to many doubtless were no more repugnant than the Latin and Logic which were the chief articles in their mental diet. In Germany the annual school festival was called the Procession of the Rod. "Led by the teachers, and accompanied by half the town, the schoolboys went into the woods, where they themselves procured the materials for their own castigation. When this was done they amused themselves with gymnastic feats and other sports under the trees, and ended up with a feast, given by their parents and teachers, and then returned to the town, laughing and joking, and laden with the instruments for their punishment."[1]

[1] Janssen: *History of the German People at the Close of the Middle Ages,* Vol. I., p. 76.

General Survey of Mediaeval Physical Training.

Reviewing the common life of boys in the Middle Ages, then, we see that though there was much physical exercise and many games, and though none was debarred from taking part in them by being immured in a dense town extending for miles in every direction around him, and with little or no open space for play; and though, on the other hand, schools were numerous and well attended; yet that intellectual and physical training were not welded into one harmonious whole.

In comparing this with ancient Athens it must be borne in mind that in the latter the full education we have sketched was only the heritage of the sons of the free citizens, who were a minority of the total population. Yet it is evident that the Christian distrust of the body—"the flesh lusteth against the spirit, and the spirit against the flesh; and these are contrary the one to the other"[1]—took in the Middle Ages a form which in fact defeated its own object. For physical vitality must find a vent, and if the superabundant energies of youth are not directed into desirable channels they will expend themselves in undesirable ways, and the fact that they are indulged in, though forbidden, is evidently antagonistic to the development of a law-abiding spirit. Plato saw the dangers of appetite—that "many-headed monster," as he called it—as plainly as did mediaeval monks and clergy, but he also saw clearly, what was not evident to them, that it is by regulation and control, not by attempted negation and annihilation, that the battle of the spirit against the flesh is to be won.

The education of girls was, throughout the Middle

[1] Gal. v. 17.

Ages, essentially domestic, though ladies went riding and hawking, and peasant women worked much in the fields.

The Education of Chivalry.

There was, however, one mediaeval institution—and that an essentially educative one—which in its theory did regard life as a whole, however much in its practice it may have made it little but physical and military. That was Chivalry, which in its essence was an order of merit. The knight was not born to the honour—he had to attain it by valour and other chivalric virtues. The whole institution enjoyed the benediction of the Church, and the ceremonies of initiation into knighthood were largely religious.

Under chivalry the castle of every noble was a school to which sons of gentlemen were sent soon after seven years of age. As pages they learned the rules of courtesy and the usages and amusements of polite society from the ladies of the house, were taught to read and write by the chaplain, and at the same time took the first steps in their military training. All kinds of exercises were taught them, such as wrestling, boxing, leaping, running, riding, throwing darts and spears, and perhaps tilting at ring or quintain. Their instructors were the squires, who were required "to learn them to ride cleanly and surely, to draw them also to jousts, to learn them wear their harness, to have all courtesy in words, deeds, and degrees . . . moreover to teach them sundry languages and other learnings virtuous, to harping, to pipe, sing, dance . . . with corrections in their chambers." [1]

At fourteen the boy became a squire and his attendance was thenceforth on his master, though he might still play chess or sing verses in his lady's bower. On the physical side the training was essentially military, and to learn the

[1] Liber Niger in *Household Ordinances*, p. 45, quoted by Furnivall: *Forewords*, E.E.T.S., 1867, p. ii (spelling modernised).

management of the long lance, which was so characteristic an arm of the armoured knight, was no small part of it. The chief mode of acquiring this skill was by tilting at a suspended ring so as to carry it away on the point of the lance, or at the quintain, a target turning on a pivot and taking many fanciful forms, not infrequently that of a man, but always so contrived that if not struck fairly in the centre it swung round and gave the unskilful striker a clout on the back, a smothering with meal, or a sousing with water.

In the history of Boucicaut, a marshal of France who was one of the prisoners taken at Agincourt, we have a vivid, if in parts somewhat highly coloured, picture of the exertions of a young squire to make himself worthy of knighthood: "Now cased in armour, he would practise leaping on to the back of a horse; anon, to accustom himself to become long-winded and enduring, he would walk and run long distances on foot, or he would practise striking numerous and forcible blows with a battle-axe or mallet. In order to accustom himself to the weight of his armour, he would turn somersaults whilst clad in a complete suit of mail, with the exception of his helmet, or would dance vigorously in a shirt of steel; he would place one hand on the saddle-bow of a tall charger, and the other on his neck, and vault over him. . . . He would climb up between two perpendicular walls that stood four or five feet asunder by the mere pressure of his arms and legs, and would thus reach the top, even if it were as high as a tower, without resting either in the ascent or descent. . . . When he was at home he would practise with the other young esquires at lance-throwing and other warlike exercises, and this continually." [1]

[1] Quoted by Lacroix: *Military and Religious Life in the Middle Ages*, p. 146.

But chivalry was essentially an institution suited to a continuous state of war. It had regulated the warlike spirit and made it amenable to the laws of honour, and, so far as was possible, to the dictates of religion. As conditions changed, and feudal fiefs were consolidated into kingdoms, the opportunities for war became fewer. Moreover the conditions of war were totally altered by the invention of gunpowder, though the supremacy of the armoured knight had for some time before been challenged by pike and bow. So the tournament, which had been a real field for training and practising the knightly ideal, degenerated into mere amusement, and ceased to be a true school of war. The signs of decay which were evident in the fourteenth century became more and more strongly marked in the fifteenth, and in the sixteenth chivalry may be said to have died.

On its general influence Mr. Cornish well says: "Chivalry taught the world the duty of noble service willingly rendered. It upheld courage and enterprise in obedience to rule, it consecrated military prowess to the service of the Church, glorified the virtues of liberality, good faith, unselfishness, and courtesy, and, above all, courtesy to women. Against these may be set the vices of pride, ostentation, love of bloodshed, contempt of inferiors, and loose manners. Chivalry was an imperfect discipline, but it was a discipline, and one fit for the times. It may have existed in the world too long: it did not come into existence too early: and with all its shortcomings it exercised a great and wholesome influence in raising the mediaeval world from barbarism to civilisation."[1]

6. Not only chivalry but the whole of the mediaeval organisation of European society was breaking up under a

[1] *Chivalry*, pp. 27-28.

new spirit of enterprise and of individual independence.

Physical Education in the Renaissance.

To this that revived interest in the ancient literatures and arts of Greece and Rome which we know as the Renaissance contributed in no small degree. As the old pagan spirit was absorbed, the dignity and worth of man's life here on earth was again recognised, and at first it seemed as if the Italy of the fifteenth century might evolve a conception of education as harmonious as that of ancient Athens. The princely Renaissance schools—notably that at Mantua over which Vittorino da Feltre presided from 1423 to 1446—made physical training an essential part of education, and insisted on exercise in riding, running, leaping, fencing, and games of ball being taken in the open air daily, regardless of the weather.

The Theory.

This practice was quite in harmony with the writers on education, whose tracts, indeed, were little more than reproductions of classical treatises. They had in view very largely the education of princes and nobles, and partly on this account, partly because war was still so common, partly because of the chivalric tradition, training in military exercises plays an important part in their schemes. The general spirit of their teaching is best represented in English in Sir Thomas Elyot's *Boke named the Governour*, published in 1531, which owed much to the Italian writers of the preceding century.

Elyot devotes considerable space to physical exercises, which are "apt to the furniture of a gentleman's personage, adapting his body to hardness, strength, and agility, and to help therewith himself in peril, which may happen in wars or other necessity."[1] The exercises are examined in detail, the possible advantage of each in war is brought out. Hunting is commended, especially if most "of the

[1] Chapter XVI.

disport be in pursuing with javelins and other weapons, in manner of war."[1] On dancing Elyot has much to say, and from its practice he anticipates many worthy results, such as the development of magnanimity, constancy, honour, wisdom, continence, and prudence, provided only that the two sexes dance together.

In 1557 Andrew Borde in his tract on *Sleep, Rising, and Dress* advises his reader: "Before you go to your refection moderately exercise your body with some labour, or playing at the tennis, or casting a bowl, or poising weights or plummets of lead in your hands, or some other thing, to open your pores and to augment natural heat."

In France, Rabelais, in his *Gargantua*, first published in 1532, advocates the fullest physical culture, and gives his giant hero a surfeit of every exercise known at the time, pupil and tutor "gallantly exercising their bodies as before they had done their minds." Nor were military exercises omitted. Gargantua "did cast the dart, throw the bar, put the stone, practise the javelin, the boar-spear or partisan, and the halbert." He also did wonderful feats with the cross-bow, and in climbing, poising weights, and other exercises "for the strengthening of his nerves." Amid all the exaggeration everywhere present in Rabelais, the doctrine that physical training is an essential part of education is evidently asserted.

Some half a century later Montaigne taught the same doctrine. In his essay *Of the Education of Children* he says "it is not enough to fortify his soul, you are also to make his sinews strong; for the soul will be oppressed, if not assisted by the body, and would have too hard a task to discharge two offices alone. . . Inure him to heat and cold, to wind and sun, and to dangers that he ought to despise. Wean him from all effeminacy in clothes and

[1] Chapter XVIII.

lodging, eating and drinking; accustom him to everything, that he may not be a Sir Paris, a carpet-knight, but a sinewy, hardy, and vigorous young man." And again, "Our very exercises and recreations, running, wrestling, music, dancing, hunting, riding, and fencing, will prove to be a good part of our study. I would have his outward behaviour and mien, and the disposition of his limbs, formed at the same time with his mind. It is not a soul, it is not a body, that we are training up; it is a man, and we ought not to divide him into two parts; and as Plato says, we are not to fashion one without the other, but make them draw together like two horses harnessed to a coach."

The Practice.

In theory, then, the Renaissance writers on education fully recognised that the body as well as the mind needed culture, and that the latter could not be properly developed unless the former was also trained. And in the life of the gentry, especially in England, outdoor sports continued to play an important part. In the time of Queen Mary, the Venetian ambassador, Giacomo Soranza, writes that the English nobility live much in their country houses, where "they occupy themselves with hunting of every description, and whatever else can amuse or divert them," and towards the end of the century the secretary of a German prince who had visited England bears similar testimony. "But," goes on our Venetian, "the English do not delight much either in military pursuits or literature, which last, most especially by the nobility, is not held in much account, and they have scarcely any opportunity for occupying themselves with the former, save in time of war, and when that is ended they think no more of it, but in battle they show great courage and great presence of mind in danger, but they require to be largely supplied with victuals."[1]

[1] Quoted in *Illustrated History: Tudor Period*, p. 154.

The custom of wearing swords and daggers led, of course, to the learning of fencing and sword play, and in 1565 Elizabeth found it necessary to issue a proclamation to limit and control "the schools of fence," in which not only gentlemen but "the multitude and the common people" were being taught "to play at all kinds of weapons," and to regulate the size of dagger and rapier.

We get a glimpse at the common sports in Scotland in James Melville's account of his boyhood at Montrose, about 1570, where he tells us he was taught archery and single-stick, and to run, leap, swim, wrestle, and play golf.

In a contemporary poem by Johnson, Headmaster of Winchester from 1560 to 1571, we have an account of life at that famous old school in the middle of the sixteenth century. Among other things he describes the "Procession" up St. Catherine's Hill which the boys made three times a week, the only occasions on which they were not confined to the college meadow. When "the top of Hills is reached, they break off, but must not go beyond Trench, nor dare to sit on the ground for fear of fever. Then they play games, quoits, hand-ball, bat-ball, or tennis, or foot-ball, and other games."[1]

Other evidence of the recognition of games in English schools is afforded by the ordinances made by the bailiffs of the town on the re-foundation in 1549 of Shrewsbury School, after the destruction of the old Church schools by the dissolution of the monasteries and by the Chantry Acts. These ordinances "direct that the scholars shall play only on Thursday, unless there be a holy-day in the week, or at the earnest request of some man of honour, or of great worship, credit, or authority. Their play was to be 'shooting in the long bow, and chess play, and no other games,

[1] Leach: *History of Winchester College*, p. 270.

unless it be running, wrestling, or leaping, and no game to be above 1d., or match over 4d.' It is further provided that on every Thursday 'before they go to play,' the scholars 'shall for exercise declaim and play one act of a comedy.'"[1]

Similar evidence of the attempt to maintain archery as a school sport is found in the provisions made for Harrow School by its founder, John Lyon, in 1571. These required all parents sending boys to the school to "allow them at all times bow-shafts, bow-strings, and a bracer." Long after archery had ceased to have a military significance it was continued as one of the recognised sports at Harrow, and annual shooting matches were held. "Originally six, but subsequently twelve, boys contended for a silver arrow. These competitors were all habited in fancy dresses, usually of silk or satin, spangled; the colours white and green, or white and red, with sashes and caps of silk to match. He who shot within the three circles of the target was saluted with a flourish of French horns, and he who first sent twelve arrows nearest the central mark was proclaimed victor, and carried home the silver arrow amid the acclamations of the school."[2] However, the artificiality and indifference of the eighteenth century were too strong for the old custom, and after 1771 the Harrow shooting matches are heard of no more.

Mulcaster.

The best testimony to the fact that in the sixteenth century some English school authorities were interested in physical education is furnished by the writings of Richard Mulcaster, the first Head Master of the school founded in 1561 by the Merchant Taylors' Company. He retained that position for a quarter of a century, and was afterwards High

[1] Staunton: *The Great Schools of England*, p. 426.
[2] *Ibid.*, pp. 332-3.

Master of the yet more famous school of St. Paul's. In 1581 Mulcaster published his *Positions*, certainly one of the soundest treatises on education produced by the Renaissance. "This work," as he says in his Dedicatory Epistle to Queen Elizabeth, "pretendeth a common good, because it concerneth the general train and bringing up of youth, both to enrich their minds with learning, and to enable their bodies with health."

About one-third of the whole treatise is devoted to the physical side of education. First the necessity of physical training is emphasised: "For as the powers of the soul come to no proof, or to very small, if they be not fostered by their natural train, but wither and die, like corn not reaped, but suffered to rot by negligence of the owner, or by contention in challenge: even so, nay much more, the body being of itself lumpish and earthy, must needs either die in drowsiness, or live in looseness, if it be not stirred diligently to the best."[1] On the other hand, if due exercise be taken much advantage ensues. "Be not these great benefits? to defend the body by defeating diseases? to stay the mind, by strengthening of her mean? to assist nature being both daily, and dangerously, assailed both within and without? to help life to continue long? to force death to keep far aloof?"[2] But to secure these benefits "the exercises must alter and be appropriate to each," because "all constitutions be not of one and the same mould."[3]

Mulcaster divides exercises into three main classes. "All exercises were first devised, and so indeed served, either for games and pastime, for war and service, or for surety of health and length of life, though sometime all the three ends did concur in one, sometimes they could

[1] *Positions*, Chapter 6 (spelling modernised).
[2] *Ibid.* [3] *Ibid.*

not."[1] He then discusses the exercises in detail, telling us that "out of the whole heap I have picked out these for within doors—loud speaking, singing, loud reading, talking, laughing, weeping, holding the breath, dancing, wrestling, fencing, and scourging the top. And these for without doors—walking, running, leaping, swimming, riding, hunting, shooting [*i.e.* archery], and playing at the ball." To the objection that "some of them may be said to be most proper to men, and far above boys' play," he answers, "you must remember that I deal for all students, and not for children alone, to whom it is in choice, besides all these to devise other for their good, as circumstance shall lead them."[2]

As to laughing and weeping, Mulcaster includes them, "seeing that they are thought to stir and clear some parts," but he values them inversely to the custom of the schools of his day. "The more children laugh for exercise, the more lightsome they be; the more they weep, if it be not in jest, so much the worse in very good earnest."[3]

Football was then popular, but was played in so rough a fashion that Elyot had condemned it as a game "wherein is nothing but beastly fury and extreme violence; whereof proceedeth hurt, and consequently rancour and malice do remain with them that be wounded; wherefore it is to be put to perpetual silence."[4] Towards this game Mulcaster takes his usual sane and judicious attitude, urging for reform and not abolition. "Football," he says, "could not possibly have grown to this greatness that it is now at, nor have been so much used as it is in all places, if it had not had great helps both to health and strength, and to me the abuse of it is a sufficient argument that it hath a right use; which being revoked to his primitive will both

[1] *Positions*, Chapter 8. [2] *Ibid.*, Chapter 9.
[3] *Ibid.*, Chap. 14. [4] *The Governour*, Book I., Chap. XXVII.

help strength and comfort nature: though as it is now commonly used, with thronging of a rude multitude, with bursting of shins and breaking of legs, it be neither civil, neither worthy the name of any train to health."[1]

To obtain full value from exercises Mulcaster insists that, so far as possible, they should be performed in the open air, and that the most profitable time is the morning "somewhat before meat." There should be neither excess nor defect. "All they which use exercises use them either not so much as they should, and that doeth small good; or more than they should, and that doeth much harm; or so as they should, and that doeth much good."[2] Much depends on age. "Men of middle age must of necessity keep the mean limit, because too much offends them, too little doeth them little good; both hinder the state of their bodies. Youth from seven till one and twenty will abide much exercising very well: wherefore they are allowed without danger to be hot and chafe, to puff and blow, to sweat, to be weary also to some degree of lassitude. . . . And yet there must be great eye had to them that they keep within compass, and so much the more the less they be above seven year old."[3]

To secure this, the physical training of school boys should be under supervision, and in order that it may be fitted as an integral factor into one educative process Mulcaster would place it under the schoolmaster. "In this my train I couch both the parts under one master's care. For while the body is committed to one, and the soul commended to another, it falleth out most times that the poor body is miserably neglected, while nothing is cared for but only the soul."[4]

[1] *Positions*, Chapter 27.
[2] *Ibid.*, Chapter 33. [3] *Ibid.*
[4] *Ibid.* Chapter 35.

Of course this requires skill in the master, "for if he be skilful himself it almost needs not to give precept," and "your skill is small to think that any small skill can do anything well." But this will be attained if once the schoolmaster "be ravished with the excellence and worthiness of the thing which he is to execute" and believe that "he may very easily attain unto some singular knowledge in so noble a subject."[1] In nothing will real skill be more shown than in that discretion which adapts the exercises to each individual case.

Throughout, the discussion is of the utmost interest, and from the intimate way in which Mulcaster speaks of the details of the training and the earnestness with which he recommends it it is not a violent inference to suppose that something of the kind was practised in his time at the Merchant Taylors' School, though there were no signs of it in the next century. He acknowledges his indebtedness to the work of "Hieronymus Mercurialis, a very learned Italian physician now in our time, which hath taken great pains to sift out of all writers whatsoever concerneth the whole Gymnastical."[2] The treatment of the subject in Mercurialis' *De Arte Gymnastica* was, indeed, more exhaustive than that of Mulcaster—another instance that Renaissance theory recognised the importance of the subject.

Physical Education in the Seventeenth and Eighteenth Centuries.

7. Mulcaster himself, however, has hinted at an increasing practical neglect of the subject in schools—"most times the poor body is miserably neglected." This neglect was yet more universal on the continent.

Both in Germany and in England an immediate effect of the Reformation had been the suppression of many

[1] *Ibid.* [2] *Ibid.*

schools, especially those connected with monasteries and chantries, and thus the cessation of formal education for many boys. No longer united by the bond of fellowship involved in being schoolmates, they roamed the streets of the towns and the lanes of the villages, developing a lawlessness of which there are many and bitter complaints in the writings of the time. When schools were re-established, or new ones founded, they were dominated by the later Renaissance worship of literary form, and made it their one aim to teach their pupils to speak and write Latin as nearly as might be in the style of Cicero. It is true that Luther commended physical exercises as preventives of drunkenness and other vices, and that Trotzendorf, the disciple of Melancthon, permitted the boys in his school to wrestle and run, though he forbade them to skate or slide on the ice or to throw snowballs in the winter, and to bathe in cold water in the summer. But the fashion for the schools of Protestant Europe was set by Sturm, rector of the gymnasium at Strasburg from 1537 to 1584, into whose conception of a complete education physical training did not enter.

General Decadence.

In Catholic Europe the great educators were the Jesuits, who regarded bodily exercise mainly as a means of recreation, to be encouraged only so far as it was necessary to enable the mind to do the most efficient intellectual work.

Moreover, there was spreading throughout Protestant Europe a form of Puritan asceticism which differed from the asceticism of the middle ages in that, while the latter was individual and voluntary, the former aimed at being universal and compulsory. First seen in its severest form at Geneva under the rule of Calvin, it spread north, dominated Scotland under the Kirk, and established a short-lived reign in England under the Commonwealth. Drawing their inspiration in this, as in other matters, largely from

the Old Testament, the Calvinists transferred to the Christian Sunday the regulations imposed in quite other conditions by the Mosaic law for the observance of the Hebrew Sabbath. Sunday had in mediaeval times been a holy day, and, like other holy days, had been marked by attendance at church. But after that duty was performed it was considered quite consistent with the "keeping holy" of the day to engage in those physical exercises which conduced to health both of body and mind. This was abhorrent to the Calvinists, to whom, indeed, innocent enjoyment at any time was looked upon at the best with suspicion.

The gradual spread of these opinions led naturally to a decay of physical exercise among adults, for Sunday was the only day available to the majority for such pursuits. This reacted on the minds of the youths, ever anxious to imitate their elders. "The Lord's Day," says Fuller, "began to be precisely kept, people becoming a law to themselves, forbearing such sports as were yet by statute permitted; yea, many rejoicing at their own restraint herein. On this day the stoutest fencer laid aside his buckler; the most skilful archer unbent his bow, counting all shooting beside the mark; nay games and morris-dances grew out of request."[1]

James I. made an effort to check this movement by issuing his *Declaration of Sports* in 1618. In the course of this document he says: "As for our good people's lawful recreation, our pleasure likewise is, that after the end of Divine service, our good people be not disturbed, letted, or discouraged from any lawful recreation, such as dancing, either men or women, archery for men, leaping, vaulting, or any other such harmless recreation. . . . But withal, we

[1] Quoted in *Social England*, Vol. IV., p. 33.

do here account still as prohibited all unlawful games to be used upon Sundays only, as bear and bull-baitings, interludes, and at all times to the meaner sort of people, by law prohibited, bowling."[1] However, the Puritan outcry which followed caused the Declaration to be withdrawn. It was reissued by Charles in 1633, but when the Puritans obtained the ascendency ten years later it was ordered to be burnt publicly, and "all persons were forbidden under heavy penalties, to be present on the Lord's Day at any wrestling, shooting, bowling, ringing of bells for pleasure, masques, wakes, church-ale games, dancing, or other pastime."[2] Next year all games and sports, all buying and selling, and all worldly labour except the "dressing of meat in private families" were forbidden.

Under the Commonwealth these laws were strictly enforced, and games and amusements on other days than Sunday were regarded with the utmost disfavour by the authorities. In Scotland the feelings of the Calvinist preachers were shared fully by the people, the majority of whom became noted for gravity of manners, but in England there was a considerable reaction after the Restoration. Some of the old games and sports were again indulged in, but the tendency was rather to participate in the more undesirable of the old amusements, such as cock-fighting, bear-baiting, and prize-fighting, than in those which are of value in promoting health and manliness. Moreover, the sabbatical tradition as to Sunday remained sufficiently strong to keep people from harmless sports if it was not efficacious in restraining them from vicious indulgences.

An idea of the games played by children in Germany, and probably in England, in the middle of the seventeenth

[1] *Somers Tracts.* [2] *Social England,* Vol. IV., p. 229.

century may be gathered from the list given by Comenius in the *Orbis Pictus*, a school book intended to teach Latin and at the same time to draw attention to the common things of life. After chapters describing fencing, tennis, dicing, and racing, Comenius gives one to Boys' sports: "Boys use to play either with bowling-stones or throwing a bowl at nine-pins; or striking a ball through a ring with a bandy; or scourging a top with a whip; or shooting with a trunk and a bow; or going upon stilts; or tossing, and swinging themselves upon a merry-rotter."[1]

The gradual declension even of the gentry of England during the seventeenth century from the standard of physical life of their fathers is shown in Peacham's *Compleat Gentleman*, a treatise on education published in 1634, which gives a trustworthy record of the manners, education, and way of thinking of the cavaliers of the time. Peacham complains of "that effeminacy of the most, that burn all day and night in their beds, and by the fireside."[2] He recommends the practice of running, leaping, swimming, hawking, hunting, and above all archery, which "is a very healthful and commendable recreation for a gentleman; neither do I know any other comparable unto it for stirring every part of the body." But he objects to throwing and wrestling as "exercises not so well beseeming nobility, but rather soldiers in a camp or a prince's guard." Nor is he inclined to "running at the tilt," for though it "is a generous and martial exercise," yet it is "hazardous and full of danger."[3]

The Courtly Academies.

No clearer proof can be given of the dislocation between the studies of the schools and universities with their arid scholasticism and the actual life of the world than the establishment of the Courtly Academies in France. Chivalry was

[1] Chapter 136. [2] Chapter 16. [3] *Ibid.*

dead, but these academies were glorified successors of the schools which chivalry had maintained. They were first founded by great nobles in the closing years of the sixteenth century essentially as schools of arms, but before long they developed into schools of liberal culture as well.

In Evelyn's *Diary* we have brief notices of two of these academies. He tells us[1]: "I often went to the Palais Cardinal, bequeathed by Richelieu to the king, on condition that it should be called by his name. . . . Here I also frequently went to see them ride and exercise the great horse, especially at the Academy of Monsieur du Plessis, and de Veau, whose schools of that art are frequented by the nobility; and here also young gentlemen are taught to fence, dance, play on music, and something in fortification and the mathematics. The design is admirable, some keeping near an hundred brave horses, all managed to the great saddle." Five months later he visited the Academy at Richelieu which the Cardinal himself had founded in 1640. In this Academy "besides the exercise of the horse, arms, dancing, etc., all the sciences are taught in the vulgar French by professors stipendiated by the great Cardinal."[2]

Similar academies were established in Germany under the name of *Ritterakademien*, which from the middle of the seventeenth to the middle of the eighteenth century gave the young German nobility a courtly and military education calculated to fit them to lead the life to which manhood would call them.

In England Academies did not flourish, though Milton wrote his *Tractate on Education* to advocate their establishment and to suggest how they should be organised. The

[1] Under date April 6, 1644.

[2] Under date September 14, 1644.

day's work was to be divided into three parts, "their studies, their exercise, and their diet." Their exercises were to be both military and general, and the whole scheme was designed to give "a complete and generous education, that which fits a man to perform justly, skilfully, and magnanimously all the offices, both private and public of peace and war."

Locke.

English education, then, never felt the stimulating influence of academies which, by their attention to the real demands of life, did much to awaken the secondary schools of France and Germany from their scholastic lethargy. The young English gentleman finished his education by making "the grand tour" and visiting the chief countries of Western Europe. At home, no doubt, schoolboys played games, but there was no positive care by the schools for their physical training. The writers on the subject of bodily education treat it more and more as essentially a matter of hygiene and medicine. Locke, for example, whose *Thoughts concerning Education* was published in 1692, has much to say on securing healthy conditions of life, but very little about exercise. He recommends "playthings . . . as tops, gigs, battledores and the like, which are to be used with labour"[1] for young children. As to youths, "fencing and riding the great horse are looked upon as so necessary parts of breeding that it would be thought a great omission to neglect them."[2] Locke would personally prefer wrestling to fencing, which he thinks "a good exercise for health, but dangerous to the life." "But," he concludes, "since fencing and riding the great horse are so generally looked upon as necessary qualifications in the breeding of a gentleman, it would be hard wholly to deny any one of that

[1] § 130. [2] § 198.

rank these marks of distinction."[1] But of an adequate conception of physical training as an integral part of education and of its nature if it is to be successful there is little or no trace in Locke. And the writers of the early eighteenth century who advocate physical exercises do so mainly on the ground of their medicinal effect in remedying disorders.

Helvetius.

In the seventh decade of that most artificial and conventional century the French philosopher Helvetius wrote: "Corporeal education is neglected by almost all European nations: not that governments directly oppose improvements in this part of education; but that exercises of this sort being no longer in vogue, are no longer encouraged.

"There is no law that forbids the laying out of a suitable ground in a college, where the students of a proper age may exercise themselves in wrestling, running, leaping, swimming, throwing or lifting of weights, etc. If in this ground, constructed in imitation of the gymnasium of the Greeks, prizes were to be decreed for the conquerors, there is no doubt but they would rekindle in youth the natural disposition they have for such games. . . . A child may consecrate every day seven or eight hours to his serious studies, and four or five to exercises more or less violent, and thus he will at once invigorate both body and mind."[2]

English School Sports.

The English plan of educating the boys of the higher classes in boarding schools no doubt led to there being a greater zest for games among English boys than among their continental fellows. If the schoolmasters took no part in the physical training but the negative one of not interfering with the

[1] § 199.

[2] *A Treatise on Man, his Intellectual Faculties, and his Education*, Section X., Chapter 4.

boys' leisure, yet that was in itself no small gain; it was seed out of which our system of public school athletics has grown. In a "manuscript drawn up by some boy, in 1765 or 1766, and entitled *Nugae Etonenses*," there is "a list of games in vogue" at Eton: "Cricket, Fives, Shirking Walls, Scrambling Walls, Bally Cally, Battledores, Peg-top, Peg in the Ring, Goals, Hopscotch, Headimy, Conquering Lobs, Hoops, Marbles, Trap-ball, Steal Baggage, Puss in the Corner, Cut Gallows, Kites, Cloyster and Flyer Gigs, Tops, Humming-tops, Hunt the Hare, Hunt the Dark Lanthorn, Chuck, Sinks, Starecaps, Hustlecap, Football, Slides in School, Leaping poles, Slides down the sides of the stairs from Cloyster to College Kitchen."[1] Many of these are obviously games played by the younger boys, and as provision for a full physical training the whole collection is inferior to the sports of earlier centuries.

Revival of Physical Education.

Rousseau.

8. The advocacy of physical training by Helvetius was quite in line with the idea of a return to nature in education and in life so eloquently voiced by Rousseau in the *Emile*.[2] False as is the fundamental conception of the purpose and value of life which underlies that book, yet in its denunciations of the artificialities of the eighteenth century, and in its appeals to men to live as men and to bring up their children to be men, it was abundantly justified. Its essential teaching on physical education is perhaps nowhere more clearly stated by Rousseau than in the passage: "If you wish to cultivate the intelligence of your pupil, cultivate the powers it should rule. Exercise his body continually; make him strong and healthy that you may make him wise and reasonable; let him work, let him act, let him run, let him shout, let him be always on

[1] Lyte, *History of Eton College*, 3rd Ed., p. 328.
[2] Published in 1762.

the move. Let him be a man in vigour, and soon he will become one in reason."[1]

Basedow.

The *Emile* became immediately famous, and its influence on education for the past century and a half has been enormous. Even the great ladies of France began to nurse their own children. But it was in Germany that the return to more natural conditions was first attempted. In the Philanthropinum[2] at Dessau, Basedow, amid many eccentricities and not a little charlatanism, endeavoured to give a more national and practical education than did the schools of the day, and as one means to that end he introduced a definite set of physical exercises—dancing, riding, turning, planing, carpentry, and walking—all under the direction of the teachers. There were also races and wrestling in the open air. To Basedow belongs the honour of first, since the days of Greece, making physical training a definite part of the curriculum of the ordinary school, as distinct from such special schools as those of chivalry and the Courtly Academies.

Gutsmuths.

Salzmann, one of the teachers of the Philanthropinum, in 1784 founded the institute at Schnepfenthal, where he followed the Dessau practice in physical exercises. Next year he associated with himself Johann Gutsmuths and put the school gymnastics into his charge. Gutsmuths gave much thought to the matter, and may be said to have laid deep and sure the foundations of modern German school gymnastics. Under his charge, says von Raumer in his *History of Pedagogy*, "the children played, not only for the sake of relaxation from the labour of the school, but their bodily exercises were made a necessary part of their intellectual training

[1] *Emile*, Book II. [2] Established in 1774.

and an indispensable department of instruction in the school."

After eight years' experience Gutsmuths published his *Gymnastics for Youth*, a book which attracted much attention and exercised a wide influence, translations being made into English, French, and Danish.[1]

In the Preface the key-note is struck: "Learning and refinement are to health and bodily perfection what luxuries are to necessaries. Is not then our education depraved when it aims at a luxury and neglects our greatest and most essential want. This thought is the foundation of my work: may it not only be laid to heart, but have a practical effect on education in general."[2]

He does not claim to have based his work on deep researches into physiology, though he grants that "a genuine theory of gymnastics" should be so based; such a system would require deep physiological and medical knowledge on the part of schoolmasters, which they certainly did not possess. His own work is "built solely on the genuine experience of eight years' practice."[3] But he thinks this is no drawback to its practical utility. "How far the physiological knowledge of the ancient Greeks extended, it is not for me to determine: but this at least is certain, that long practice had convinced them of the advantage and utility of gymnastics to youth, and to the nation at large, before they thought of applying medical theory to the subject."[4]

The first part of Gutsmuths' book is taken up with arguments to convince his age of the practical importance of the subject. He gives a gloomy picture of eighteenth century practice. The training of the well-to-do led to

[1] The English translation is anonymous, and the translator has erroneously ascribed the work to Salzmann.

[2] Eng. Trans., p. viii. [3] *Ibid.* [4] *Ibid.*, pp. ix-x.

effeminacy of character and weakness of health. The young boy "is muffled up from head to foot; he reposes on a heating feather bed; his diet consists of the complicated dishes in which adults indulge themselves."[1] On the contrary "the time is now arrived when his body, be it ever so delicate, ought to be exercised the greater part of the day in the open air, in heat and cold, in wind and rain, to fortify it against the influence of the weather; to strengthen his limbs by strenuous exertions in walking, running, jumping, throwing, etc., and foster in his mind the germs of courage, perseverance, activity, and reflection on the objects of nature."[2]

At school "everything is calculated for the formation of the mind, as if we were altogether without bodies."[3] This "is an unpardonable fault: it is a bad sign that no one can discover the idea of bodily improvement in the compound idea expressed by the word school."[4] It is true the richer boys learn to dance and to fence. But the former "contributes little or nothing, as a bodily exercise, to the attainment of a nobler end; to the attainment of that which we would call in a single word, manhood."[5] And as to fencing, it "is an exercise of admirable utility in itself: it strengthens the body and infuses courage, but it is applicable only in later years and has a connexion too dangerous with what is called the point of honour."[6] The poor are still worse cared for. "In the present situation of things, teaching, not education, being the office of schoolmasters, the class of working people can do nothing for the bodily formation of their children."[7]

But it is not simply neglect of positive bodily training which is bringing about deplorable results, everywhere only

[1] *Ibid.*, p. 7. [2] *Ibid.*, pp. 7-8. [3] *Ibid.*, p. 9.
[4] *Ibid.*, p. 10. [5] *Ibid.*, p. 13. [6] *Ibid.* [7] *Ibid.*, p. 15.

too apparent. "This want of bodily exercise, it is true, I consider as a prime cause of debilitation, but our luxurious tables, and the clothing of our youth, are assuredly powerful auxiliaries."[1]

These positions Gutsmuths develops at considerable length. He grants that "since the appearance of the modern mode of education, as it has been called, but which the learned know may be found in Plato and other Greeks; since the promulgation of the principles of Locke, Rousseau, Basedow, and Salzmann; the night of monastic education, as everyone knows, has gradually dispersed."[2] Yet the advance has been one-sided. "The improvements of our great public schools deserve much praise: but they are confined to the methods of teaching, new sciences, more regard to health in the construction of the appropriate edifices, and greater economy of expense."[3] Of smaller schools and private education similar remarks may be made. Indeed, only a "short view is sufficient to discover the few steps that have been made towards the physical improvement of education in private families and public institutions: almost all the improvements that have been suggested lie dormant, properly speaking, in books; a few of them only have been carried into practice in private families, so that they are yet by no means to be considered as forming a part of general education."[4]

Nor can physical development be safely left to "the natural propensity of children to play about in the open air."[5] Though the children of the poor have much freedom, yet at an early age "many are obliged to perform labours above their strength. On the other hand, the sons

[1] *Ibid.*, p. 18. [2] *Ibid.*, pp. 88-89.
[3] *Ibid.*, p. 92. The reference is, of course, to German schools.
[4] *Ibid.*, p. 94. [5] *Ibid.*, p. 95.

of the superior classes are denied these means of improving their health, and in consequence remain more feeble."[1]

This all leads up to a positive advocacy of gymnastics. "The consequences of our education and mode of life . . . may be expressed by a single word, softness. . . . If we harden the body more, it will acquire more stability and firmness of nerve; if we exercise it, it will become strong and active: in this state it will invigorate the mind, it will render it manly, energetic, indefatigable, firm, and courageous; serenity will be diffused over it; it will be active as nature; it will never experience the poison of ennui. All this is to be accomplished by educating the body more hardly, and in particular by exercising it."[2]

Gutsmuths then considers and answers possible objections against his proposal: that there are no places suitable for the purpose; that there are no teachers; that time cannot be found; that such exercises will bring ridicule on the schools; that they are dangerous; that they will cultivate dislike of sedentary occupations; that they will develop rudeness of mind and self-assertion. The whole discussion throws much light on the general attitude of the later eighteenth century towards physical training.

The first part of the book concludes with a clear setting forth of the objects a good school gymnastic should aim at securing. The conclusions are thus summed up. "To facilitate the contemplation of them, I shall just repeat the desirable parallel between the qualities of the body and mind.

Health of body	...	Serenity of mind.
Hardiness	...	Manliness of sentiment.
Strength and address	...	Presence of mind and courage.

[1] *Ibid.*, p. 97.

[2] *Ibid.*, pp. 101-102.

Activity of body	...	Activity of mind.
Excellence of form	...	Mental beauty.
Acuteness of the senses	...	Strength of understanding.

"Now let me ask: are not these objects suited to our political institutions, to our manners, and to our state of civilisation? and are they not worthy the most ardent endeavours of a cultivated people?"[1]

In the second part of the work Gutsmuths describes in detail the exercises he recommends. They should be, as far as is practicable, in the open air. They should be enjoyable: "Were I to give a definition of these exercises, it would be: gymnastics are labour in the garb of youthful mirth."[2] As they are "to act as preservatives against effeminate sensuality and to steel both the physical and moral man: and therefore they must be connected with labour; require patience and perseverance; admit not of enervating rest; inure the pupil to more or less pain, that he may learn to contemn it; and expose him to the weather and the elements, to harden the integuments, which are designed to protect the whole body."[3]

The exercises discussed are leaping, running, throwing, wrestling, climbing, balancing the body, lifting, carrying, drawing objects with a cord, skipping, dancing, walking, military exercises, swimming, reading aloud, and exercise of the senses. These are then divided into four classes according as they operate generally, on the upper part of the body, on the lower part of the body, or on special parts of the body.

Then follow some general rules to be observed, the chief of which are, "Gymnastic exercises should never be performed after a meal, till the food is digested."[4] "Never let bodily exertion, or your attempts to harden the frame,

[1] *Ibid.*, p. 184. [2] *Ibid.*, p. 187. [3] *Ibid.*, p. 188. [4] *Ibid.*, p. 422.

be carried to excess."[1] "Distinguish the feeble from the athletic, and measure them not by the same standard."[2] "Observe what limbs of each young gymnic are the feeblest, and let these be particularly exercised."[3]

There is obviously much of the Greek spirit in Gutsmuths, and a good deal that reminds us of Mulcaster.

Pestalozzi.

Pestalozzi also advocated physical training, but he had a very inadequate conception of its nature. In his opinion "the essence of elementary gymnastics consists in nothing else than a series of exercises for the joints." His general advocacy, however, helped to advance the cause.

Fellenberg.

Another pioneer was Fellenberg, whose agricultural school at Hofwyl exerted a great influence both in Europe and America. Fellenberg sums up his position in the words: "Voluntary exercise is to be encouraged by providing suitable games, by affording opportunities for gardening, by excursions, and by bathing. Regular gymnastic exercises should be insisted on as a means of developing the body. A healthy action of the bodily frame has an important influence on both mind and morals."[4]

Physical Education in the Nineteenth Century.

Germany.

9. Physical training was, then, in the air in Germany at the dawn of the nineteenth century. It yet wanted a practical impulse. This was given by Frederick Jahn, a schoolmaster of Berlin, who has been called the "Father of Modern Gymnastics." It was in the spring of 1810, he tells us, writing in 1816, that "a few of my pupils began to go out with me into the woods and

[1] *Ibid.*, p. 424. [2] *Ibid.* [3] *Ibid.*, p. 425.

[4] Quoted by Mr. Boykin in a paper on "Physical Training," printed in the *Report of the U.S.A. Commissioner of Education*, 1891-1892, Vol. I., p. 486.

fields on the holiday afternoons of Wednesday and Saturday and the habit became confirmed. Their number increased, and we had various youthful sports and exercises. . . . At the present time many exercises are practised in company, in open air, and before the eyes of all, under the name of turning. But then the names turning system, turning, turner, turning ground, and the like, came up all at once and gave occasion for much excitement, scandal, and authorship. . . . In the summer of 1812, both the turning ground and system of exercises were enlarged. They became more varied from turning day to turning day, and were mutually developed by the pupils in their friendly contests of youthful emulation. It is impossible to say in detail who first discovered, tried, investigated, proved, and completed one or another exercise."[1]

The turning movement spread, but gradually lost its immediate connexion with the schools, though its members were young men who usually had not long ceased to be scholars. From the first a strongly patriotic impulse had been given to it by Jahn. This seems to have developed into excessive and premature demands for political reform. Certainly the turner societies were looked upon with disfavour by the reactionary governments, until at length all turning establishments were ordered to be closed and Jahn himself imprisoned. Though again allowed, yet in 1832 and 1848 the societies were again repressed.

Since 1860 the associations have ceased to concern themselves with politics and have flourished undisturbed, playing a part in German life somewhat analogous to that played in England by cricket, football, and other athletic clubs.

[1] In *Die deutsche Turnkunst:* translation in *Barnard's Journal of Education,* Vol. VIII., p. 196. Cited by Boykin, *op. cit.,* pp. 486-487.

Though proposals had been made as early as 1804 for the introduction of physical training into the schools of Prussia, yet it was only in 1837 that a permissive order was issued allowing gymnastics to be taught in the schools. Five years later "the King of Prussia on the combined recommendation of the ministers of education, of war, and of the interior, approved a cabinet order that 'bodily exercises should be acknowledged formally as a necessary and indispensable integral part of male education, and should be adopted as an agency in the education of the people.' The same order authorised the establishment of gymnastic institutes in connection with the 'gymnasien,' the higher middle schools, the training schools for teachers[1] and the division and brigade schools in the army."[2]

Into the elementary schools gymnastics were not introduced till 1860. No general provision is yet made for girls, though in some towns they are required to follow the gymnastic course.

In Saxony gymnastics were introduced into the higher schools and training schools for teachers in 1837, and were made compulsory in 1876. In 1863 the introduction of gymnastics into the lower schools was recommended, but without much effect for some years. In 1878 it was made compulsory.

In Hesse the organisation of school gymnastics was due to Spiess, who from 1848 till his death ten years later held high office in the department of education of that duchy. For fifteen years previously he had been teacher of gymnastics at Burgdorf, in Switzerland. There he had introduced gymnastics for girls—such as exercises with dumb-bells, running, jumping, and swinging, and also a

[1] *I.e.* the highest class of secondary schools.

[2] Boykin, *op. cit.*, p. 490.

system of simultaneous class gymnastics, performed without apparatus at the word of command. Both these features marked his administration in Hesse, and to carry it out more perfectly he himself in 1849 and 1850 conducted training courses for teachers.

Similar steps were taken by other German states, and now gymnastics is an integral part of the course in all schools.

In Prussia three hours a week in the secondary schools and two hours a week in the primary are given to gymnastics; each class having its own special time. Each school has usually its own exercise hall, and in some of the larger cities playgrounds are also provided. The exercises are graduated and include a great variety of movements both with and without apparatus. The girls have arm exercises with wands and dumbbells, skipping, marching, dancing, balancing, jumping, swinging, climbing, and games of ball, and even go through some of the easier exercises on the parallel and horizontal bars.

Of late years, too, there has been shown in Germany an increasing desire to introduce out-door games and sports into the training of the young.

Denmark.

To Denmark really belongs the honour of setting the example to other European nations in the matter of regular physical training, as she introduced gymnastics into her schools as early as 1828.

Sweden.

In Sweden the impulse towards gymnastics was given by Ling, who was born as early as 1776. He early devoted his attention to physical training and urged his views so successfully that in 1814 the Government established a Royal Central Institute of Gymnastics and appointed Ling its director. Ling wrote various practical works setting forth his system, but school gymnastics do not appear to have become a regular part of

the work of Swedish schools till some years after his death in 1839.

The characteristic feature of Swedish gymnastics is their semi-military character. Each movement is executed at the word of command by the whole body of students. The exercises are based on a physiological analysis of muscles, and in every drill it is held essential that a sequence should be kept and that the drill itself should fall into its proper place in the whole series of drills. Thus gradation can be secured, and change and variety are not eliminated.

The system has been adversely criticised by German writers, especially on the ground that it has no moral aim and no tendency to form character. It has, however, spread a good deal both in Europe and in America, where the preponderance of women teachers debars the school from attempting any full physical training of boys.

France.

In France gymnastics has been generally introduced into the schools within the last few years. So recently as 1883 Dr. Mahaffy could compare "on the one hand, the neat and well-regulated French boys of a boarding school, walking two and two with gloves on and toes turned out, along a road, followed by a master; on the other, the playgrounds of any good English school during recreation time."[1] There has been much improvement since then; now the French code requires attention to be given to games and gymnastics, and the schools are usually furnished with the necessary appliances. The idea of the need of continual supervision and regulation is, however, still practically universal, and the French youth's attitude towards games is mainly one of contempt, or, at the best, of patient tolerance. Moreover, the demands on time and energy

[1] *Old Greek Education*, p. 36.

made in the secondary schools both in France and in Germany are much heavier than is common in England. As a result games—which demand much time—are crowded out, and formal gymnastics remain practically supreme in physical training.

England.

In our own country the advance has been on quite different lines. As has been seen in the course of our brief survey, boys at the old public boarding schools have always played games. Doubtless they were in the past left too much to themselves, and the younger and weaker suffered more or less from the bullying of those older and stronger than themselves. As late as the early years of the nineteenth century a headmaster "declared that it was his duty to teach Greek but not morality ";[1] and the record of Thring's life as a scholar at Eton between 1832 and 1842 shows how much the boys were left to themselves and how little care was taken for their physical comfort.[2]

The more careful organisation and supervision of the prefect system which Arnold began at Rugby about the time that Thring was a boy at Eton did much to put the government of boys by boys on a more satisfactory footing, and to a large extent to secure the advantages of self-reliance and power of initiative without the drawbacks of cruelty and injustice.

As the century advanced, more and more cognisance was taken by the schools of the sports which occupied so much of the time and attention of the boys. Of Rugby in 1865 Staunton reports that "contiguous to the school is the 'school-close' of more than thirteen acres of grass on a light soil. It is open on three sides, and contains a gymnastic ground, good racquet courts, and on one side of

[1] Russell: *Life of Dr. Pusey*, p. 11.

[2] See Parker: *Life and Letters of Edward Thring*, Chapter II.

it a cold bath of spring water which for many years has been kept for the use of the boys.

"The management of this close, and the regulation of the sports, are commonly committed to an Assembly called the 'Big-Side Levee,' consisting of all the boys in the Upper School, led by the Sixth. The games most popular at Rugby are football, cricket, and racquets. Football is played there under different rules from those of other public schools, and with extraordinary vehemence and spirit."[1]

Similar remarks apply to the other great boarding schools. The great day schools were not so fortunate. At Merchant Taylors "the only playground is a paved space, called the Cloister, in the rear of the school, quite inadequate to the recreation of so many boys." But until it could be enlarged "the Company pay twenty guineas a year for the hire of a suitable ground for cricket."[2]

At Charterhouse, after recounting the usual sports, Staunton adds: "No athletic exercises are taught as a regular part of the education; but a Drilling and Fencing Master attend, and there was, we believe, a rifle-corps in the school, numbering 60 boys."[3]

The example of Edward Thring at Uppingham did much to improve the physical surroundings of the public school boy. On nothing did that great headmaster insist with more emphasis than on the influence of buildings on the life of the boys. At Uppingham in 1859 was opened the first public school gymnasium, and there too the experiment was begun of establishing carpentry and metal workshops, and school gardens.

At present the games of the great Public Schools are elaborately organised. Several of the masters are always

[1] *The Great Schools of England*, p. 388. [2] *Ibid.*, p. 239.
[3] *Ibid.*, p. 287.

adepts in them, and there are in addition professional 'coaches.' In cricket one of the masters is usually in joint authority with the captain of the eleven, but the management of the other sports is left in the boys' hands, though the interest and participation of the masters secure that they are in touch with all that is done. Games are generally compulsory, unless forbidden by the school doctor. Inter-school matches were made possible by the building of railways, and have done much to raise the level of play, of sportsmanship, and of school patriotism.

The charge most frequently brought against Public School Athletics is that they play too large a part in the boys' life, but not infrequently that charge is made by those who, following the evil tradition of the seventeenth and eighteenth centuries, identify education with schooling and limit schooling to intellectual exercises.

The smaller secondary schools have usually followed the lead of the great public schools, with such modifications as are demanded by differences of circumstances. With younger boys it is obvious that the management of sports must be more in the hands of the masters, who give more actual instruction in the games. This is, of course, the case with the many excellent boarding schools which prepare boys to enter the great public schools at about thirteen years of age.

The day schools have always had more difficulties to overcome than the boarding schools owing to the facts that the home life of the boys makes considerable demands on their time and that it has often been difficult to secure sufficient and suitable ground. But as a rule these difficulties have been more or less perfectly overcome, and the introduction of the 'house' system into day schools, whereby the pupils are organised into small 'houses' or groups, each under the charge of a master, has done much,

by inter-house matches, to develop the public school tone among the boys. Most secondary schools, too, have gymnasia and gymnastic instructors.

In the last half-century the physical education of girls has been made the object of more thought and care than it had received for two thousand years. To no one do the girls of England owe a deeper debt for eloquent and successful advocacy of their right to receive a full physical training than to Mr. Herbert Spencer. Girls' secondary schools now often organise their games as carefully as do those for boys.

When we turn to the primary schools the picture is not so bright. The nineteenth century inherited from the eighteenth a terrible legacy of ignorance among the poor. The industrial revolution which began in the last decades of the eighteenth century accentuated this in England. Children of both sexes and of the most tender years were 'apprenticed' to the mill-owners of Lancashire and Yorkshire, and spent a life at which the imagination shudders, and which called for the repeated intervention of the State. As Mr. de Montmorency says, speaking of the opposition to the Factory Act of 1802: "One can only wonder at the rare calibre of a manufacturer who could style as 'injurious,' 'harsh,' 'oppressive,' or 'impracticable' a measure that required, in mills where three or more apprentices were employed, the mill rooms to be ventilated; that ordered the rooms to be whitewashed twice a year; that an apprentice should have one suit of clothes a year; that an apprentice should not work more than twelve hours a day exclusive of meal times; that no work by apprentices should be done between nine at night and six in the morning; that male and female apprentices should sleep in separate rooms, and that not more than two apprentices should sleep in any case in the same bed; that the master should call in medical

attendance for his resident apprentices in case of infectious disease; that the mills should be inspected by visitors appointed by the justices; that the children should be taught the elements of knowledge and the principles of Christianity."[1]

After seventy years of effort England succeeded, by the Education Act of 1870, in securing to every child the opportunity to be taught. Six years later attendance at school was made compulsory, and in 1891 it was enacted that primary instruction should be free to all. Enormous sums were spent both by voluntary agencies and by the local authorities in providing the requisite buildings, and in keeping them abreast, as far as possible, of the teachings of modern hygiene. But the conception of education which guided these efforts was essentially the scholastic tradition, that education and instruction are synonymous. So schools were provided but no playing fields, and very often most inadequate playgrounds; laboratories were built and furnished at great cost, but few gymnasia and still fewer baths.

Nor is the truth yet generally recognised that physical training is as essential as mental cultivation. Healthy conditions of school buildings are rightly insisted upon, and in 1907 it was made obligatory on the local authorities to appoint medical officers to examine the physical condition of the school children. All this is good, for it is well to know our weaknesses. But, after all, these are only auxiliary and even preparatory steps, and if the further and more important step of training the children be not taken, much labour and money will have been expended with little result.

Nor can such training be given through instruction in hygiene and physiology. The fashionable cry for such

[1] *State Intervention in English Education*, p. 213.

instruction is only another outcome of the scholastic fallacy that instruction is the one thing needful in life, and of the yet more common confusion between knowing a thing and knowing about it. No knowledge about a practical act is of effect without the direct knowledge of it which comes from doing it. It is useless for me to be able to describe in theory the mode in which forces should be applied to divert a moving cricket ball into any one desired direction, if when I am at the wicket I inevitably get out first ball. And it is equally useless for a boy to have theoretical knowledge of the physiological effects of cleanliness, or of exercise, or of fresh air, if no occasion be given him to wash and bathe, to run and jump, and to breathe the untainted air of heaven. Very simple and very practical are the rules of the hygienic life; and these the child must apprehend by his intellect. But he must make them his own by practice. In that way, and in that way only, will he ever really and truly know what they mean. Any instruction in physiology or hygiene which goes beyond this may have an intellectual value, but has no more practical bearing on conduct than has the study of any other branch of science, say chemistry or geology.

It follows that the schools cannot truly teach hygiene until they can send their pupils to practise hygiene. It is useless to talk to children who are never washed of the pleasures and advantages of cleanliness. Schools attended by such children cannot teach cleanliness unless they are supplied with baths, and use them regularly. It is in the bath, not in the class-room, that the true lesson on cleanliness is taught.

Equally futile is it to talk to children of the advantages of exercise when their only places for play are crowded streets and a minute school playground. Doubtless the provision of adequate playing grounds will be expensive; but

so have the school buildings been, and may it not be that the former are at least equally important with the latter? Moreover, if such playing grounds were adequately used some children would always be in them, and so the amount of school accommodation required would be lessened. Of course there should be covered sheds for use in very wet weather, and dressing rooms should also be provided. For the children should be required to change into simple flannel suits for their exercises, and, when the parents cannot supply these, there seems no reason why they should not be provided as part of the school apparatus as readily as are books and other material used inside the school.

To one who really appreciates the full doctrine of education, and of physical training as an essential part of it, which it has been the object of this chapter to enforce, the most crying need in English—and indeed in European and American—education of to-day must appear to be adequate provision for physical training, and the full recognition of it as part of the teacher's work.

CHAPTER II.

PHYSICAL EDUCATION IN RELATION TO MIND AND BODY.

Physical in relation to Intellectual and Moral Education.

1. The problem of physical education is both a wide and a complex one, for it is an aspect of the wider problem of education in general, of which physical, intellectual, and moral training are collateral and overlapping branches. Clearly to grasp the full extent of its meaning we need to ask ourselves what the work of the whole human being is in life and then to understand to what extent and in what way the body plays a part in that work. From such general considerations only can the teacher attain a real and comprehensive insight into the significance of physical training.

"The purpose of Education should be to lead the child into the fullest, truest, noblest, and most fruitful relations of which he is capable with the world in which he lives." [1] The child life should lead progressively onward to an adult life full of generous and varied activities. Life, however, is always life in a particular environment of people and things. It is essentially, for the majority of men and women, a practical doing of things, the attaining of practical ends in a practical way. Practical ends,

[1] Welton, *Principles of Teaching*, p. 9.

however, are not necessarily utilitarian ends. Profession, or business, or craft is one of the concerns of life, but complete life is not confined to so narrow a sphere. Man's nature includes other elements than the desire to provide for himself and his family. Intellectual, social, and aesthetic impulses cry out for development, and unless stifled by the demands of utilitarian life will take up a large part of leisure time. Education, to attain its complete and highest end, must develop all sides of human nature, must make the most and the best of all that is in man. It should lead the child through boyhood and youth not only to be a just, honest, and well-balanced citizen, a good father, an intelligent skilled worker, but should also cultivate his tastes and train his intelligence and skill so that he can use his leisure time in ways profitable to his mind and body. Into all aspects of life—utilitarian, social, or aesthetic—practical activities enter. Health, strength, practical skill, practical judgment, and those practical elements of character that are demanded in personal dealings with people and things are as much required in the earnest and thorough pursuit of intellectual, social, and aesthetic ends as in those that are distinctly utilitarian. Education, then, has a thoroughly practical end in view. It aims at forming a man fully capable and efficient in performing all the practical duties implied in the term manhood.

It must not be thought that physical education is something apart from this. This high, broad, and complex aim is as much the end of physical as of intellectual and moral education. There are not three aims, but one aim. The three aspects of education are but factors in one process. The physical does not purpose a merely physical end, the development of the body. Its end is more human. It seeks to prepare for that aspect of life's work

in which practical activities take a prominent share. It thus embraces intellectual and moral elements, for though the physical enters largely into practical activities yet judgment and character are equally essential. So it is with the intellectual aspect of education. The physical and the moral enter into it. Strenuousness, patience, honesty, and self-control are learnt even in arithmetic and grammar lessons, and we frequently learn better by doing than by the more theoretic contemplation of things.

Life cannot be divided into watertight compartments, one labelled physical, another intellectual, a third moral; and the preparation for life will fail just in so far as artificial boundaries are erected to make the occupations and pursuits of school life solely intellectual, or moral, or physical in their character. School life will find its deepest roots in the pupil, it will have its greatest effect in moulding his habits and desires, when it approximates to the conditions of real life of the child progressing through boyhood and youth to manhood. Artificiality and formality are monotonous and deadening. Pursuits that do not appeal to the human nature that is in children as much as in men become drudgery, to be cast on one side when authority no longer compels. Only those occupations that appeal to human feelings, desires, and impulses will have a permanent place in life, and will to any great extent influence intelligence and character.

Physical education, then, if it is to be anything more than a mere formal and artificial adjunct to school life must be founded on the natural desires and instincts of childhood. The pursuits and occupations included under physical education, whilst they are physical in their character and promote health, strength, and skill, must have intellectual, social, and aesthetic factors, and hence train judgment and character. They will, in short, be the

practical aspects of intellectual, social, and aesthetic school life.

The Relation of Mental to Bodily Activities.

2. There is, thus, brought forcibly home to us the inter-relation of the physical with the other aspects of education. This problem is at bottom that of the relation of mind to body and the work of each in effective life. It is important, therefore, at the outset clearly to grasp the connexion between mental process and physical process and to understand the dependence of each in all life activity.

Life is a continual struggle with one's physical and social environment to bring oneself into proper relations to it, to know it, and to turn it to use. In this work mind and body each plays its own part.

Function of the Mind.

The work of mind is rationally to control our actions in the world around us. To do this we must know the world, construct by our intelligence the world in idea, as truly and as fully as the impressions with which our senses provide us will allow. Knowledge so gained, however, is only a means to life. The real, true life consists in the ceaseless striving after ends, the overcoming of difficulties, the continual satisfying of the demands of our nature. Bodily, intellectual, social, aesthetic, and religious cravings all demand realisation, and all have reference to something outside ourselves. All involve the continual adaptation of people and things around us. The function of intelligence is to transform these impulsive cravings into rational purposes, to know in the varying and conflicting circumstances of life as they crowd upon us wherein lies the welfare of the whole organism, a welfare permanent, lasting, and continuous throughout life. When intelligence forms such a conception of life's good, then in the midst

of the strife of inclinations and desires it becomes possible to choose the higher and to prefer the permanent and lasting good to the impulse of the moment.

Impulse is thus by intelligence subjected to purpose, which the mind sets before itself as its highest, best, and most permanent welfare. Impulses and desires, however, continually arise in conflict with the ideal good, and the mind must hold to the better and the more rational and pursue it with strenuousness and persistency. Conflict with the self, with the physical world, and with human society is inevitable, and conquest demands qualities of character that may be summed up in the word 'power'—power to subdue and to endure. Courage, fortitude, hardihood, and endurance are required to conquer in the physical, the social, and the personal struggles of life. But to begin the strife needs a consciousness of one's power and a foresight of success, and such confidence and faith in one's ability to bear and to subdue is only born of success. It is only in the successful strife with the physical world and with material objects, in the human contests with one's fellows and with oneself, when one's strength, skill, intelligence, and spirit are matched against physical and human forces, that there develops that manly and manful outlook on the world, that feeling of self-confidence, self-reliance, and self-respect that indicates one's power to conquer the world, and undaunted by it to pursue one's purposes faithfully to the end.

Much of the work of the world, however, is done by man in co-operation with his fellows, all working towards a common end, and each seeking his own good through the good of the whole community. For this co-operative work to be successful, the mind must possess knowledge of human nature, extend sympathy to others, obtain an insight into their views, and show tolerance. Power to co-operate, to

enter willingly into common ends, to deny one's own purely individual good and give obedience to law and constituted authority is necessary to harmonious social life.

In this rational control of conduct and in this power to conceive and to strive for the individual and the common good lies the marked distinction between man and the lower animals. The latter certainly seek their own welfare as far as they know it, but they seek it blindly. They are guided by instinctive impulse, but they cannot conceive of life stretching ahead, and think of and work for the welfare of generations yet unborn. They live from moment to moment. Impulse is there, but no purpose, no moral will, because there is no thought of a permanent and continuous good to which impulse and inclination must be subjected. The peculiar and distinctively human function of the human mind is conscious self-direction, the ability to conceive an ideal good, the power to choose and hold to the better, and freely and willingly to bear physical and mental hardships in the struggle to attain it.

The position of mind in the human organism, then, is that by intelligence and character it constitutes itself the controlling, governing, and directing member. Its duty is to know wherein lies the true welfare of the whole being, to be in touch with the physical and social environment, and to direct the behaviour of the whole organism in that environment so as to secure the welfare of the whole. The question then which opens up before us is: How is mind brought into relation with the external world so as to know it and use it for the attainment of human purpose?

Function of the Body.

The body is the instrument by which the mind is brought into relation with external things. Only through the medium of the body can mind execute its function of knowing the world and adapting that world to the welfare of the whole

being. It is, then, as an instrument of mind that education must seek to train the body so as to make it an instrument strong and efficient for its service.

To think of the body as something apart from the mind, to train the bodily activities separately from their relation to mental activities, is to take a narrow and false view of education. In this we are at one with the ancient Greeks, who held that the object of gymnastics was "rather to stimulate the spirited aspect of man's nature than to gain strength." A true and comprehensive conception of physical training is only possible to one who regards mental and bodily activities as being in inseparable relation with each other. The mind is that element of the organism which conceives the welfare of the whole organism and intelligently adapts and controls the environment to that welfare; the body is the instrument through which the mind works.

The Cerebrum the Organ of Mind.

The mind is not in direct relation with every part of the body. Popular opinion connects it with the brain, and this in the main is true. To speak correctly, however, the seat of consciousness is only a part of the brain, viz. the two large lobes of the fore-brain, the *cerebrum* or *cerebral hemispheres*, that overlap the smaller middle and hinder segments. Destroy the cerebrum and all consciousness ceases, and self-direction of bodily activity by intelligence and will is no longer possible. In the cerebral hemispheres is that connexion between mental and bodily process by which almost all parts of the body are brought under the control of the will, and by which the things external to the body are made to serve human purposes.

The connexion between bodily and mental process is a most mysterious one, and has occupied the thoughts of man ever since he began to try to understand his own

nature. For all practical purposes, however, the cerebrum may be regarded as the organ of mind, and mental activity as having a correlative cerebral activity. The healthy life, growth, and energetic working of the mind involve the healthy life and growth and the active vigorous functioning of the nervous tissue of the cerebral hemispheres. If the cerebrum be badly nourished, whether from defective circulation, poor blood, or weak digestion, mental activity becomes correspondingly feeble. Press for a few seconds the carotid arteries in the neck that supply the cerebrum with its life fluid and consciousness ceases. If the blood supply to the cerebrum be poor in oxygen, or impure in character, the effect is seen in headaches, languor, confused thought, irritation, and weakening of self-control and self-confidence.

The Senses.

The cerebrum, then, is the organ of mind; the supreme bodily centre through which the mind controls the rest of the body and the external world. The function of the mind being to know its environment and to adapt it to its own ends, the relations of the mind to the world must be of two kinds. On the one hand the cerebrum must be in connexion with the sense organs. To effect this, from every sense organ there pass to the cerebrum numerous nerve fibres called 'sensory.' The sense organs themselves are special structures peculiarly adapted to the reception of physical impressions. The eyes are sensitive to waves of light, the ears to vibrations of the air, the skin to molecular motion of heat and to contact, the palate and nose to the chemical activity of bodies dissolved in the mucus covering the membrane of the nasal passages and the palate. Each sense organ possesses a structure which specially fits it to receive one particular form of external force and to transmit as a consequence a nervous stimulus to the cerebrum. The nervous stimulus reaching

the cerebrum, consciousness is affected in the form of sensations of light, sound, touch, temperature, smell, taste, pressure, and movement. Such sensations, however, do not constitute knowledge of reality. They are but the way the world is presented to our consciousness. To have a knowledge of the world intelligence must so work on this presented material and bring it into relation with past experience, that it is recognised, classified and named, and judgments are passed upon it. Sensations are only the raw material from which knowledge is constructed by the activity of intelligence. During every moment of life multitudes of such sense impressions are being received. Many, however, pass unheeded. A few, from their own intensity, or from the amount of feeling they evoke, or because the intelligence seizes on them as valuable and so drags them into fuller light, are recognised and interpreted in the light of past experience and of present needs.

Some sense organs such as the eyes, ears, and nose are so constructed as to receive impressions from distant objects. Others, as the sense organs of taste and touch, require to be in actual contact with objects before they are affected by them. Still others record the state of rest or movement of the body itself and are not directly concerned with external objects, but only with the attitude of the body, in rest or motion, towards such objects. Thus, the muscles, tendons, and joints of the body are each supplied with sensory nerves, by which impressions of movement and of pressure are conveyed to the cerebrum. Intelligence can thus become aware, apart from the senses of sight and touch, of the position of the limbs, of the movements of any part of the body, and of the amount of resistance that is being overcome.

All these different sense organs united in combined action on any object give the mind a great range and variety of

impressions of that object, and they may lead it to initiate conduct that can deal effectively with it whether it be near or distant. With the hands and eyes the surface and shape of an object can be explored, and sometimes its structure can be examined by pulling it to pieces and putting it together again. By movements of the eyeballs and head the extent of large objects can be grasped when the hands fail. Walking round a large object such as a building adds experience of leg movements to that of sight. The sense of muscular exertion in overcoming resistance and counterbalancing pressure adds still further to the information gained by the active use of hands and eyes. Hands, eyes, ears, muscles, all thus assist each other, each filling out and perfecting the impressions given by others and providing together a wide variety of sensations as a basis for intelligent adaptation.

The Motor Machinery.

Such is a brief outline of the sensory connexions of the cerebrum. On the other hand, the cerebrum must be in connexion by means of 'motor' nerves with the organs of movement, that is, the muscles, in order that intelligence may adapt movement to the impressions of the external world supplied by the senses. Intelligence, interpreting the sense impressions in the light of past experience and of present purpose, issues commands for certain movements to take place. Thereupon impulses originating in the cerebrum flow outward along the motor nerves to this or that set of muscles and the appropriate movement takes place, intelligence becoming aware of the movement and its result by the continuous activity of the various sense organs. The muscles in themselves have no power to originate movement. They only contract and relax when nerve stimuli prompt them. They contain the energy of movement, the energy to overcome resistance, to put forth force, but muscular energy is only released and its

action controlled by the nerve centres which govern the muscles.

All movement, however, is not due to the activity of the will. Many movements take place independently of the will. Over some, such as the beating of the heart, we have no control; we are not even directly aware of their taking place. Of others we know what is happening, but do not initiate and can hardly control their performance. For example, if the hand touch a hot surface or be pricked by a pin it is immediately withdrawn, almost before we realise what has taken place. The eyes blink instinctively in a strong light. The arms are thrown out and the head jerked back when our balance is upset. Such movements as these are not conscious intelligent adaptations. The will does not originate them. Intelligence may be aware of what is taking place, but it is a spectator rather than an active participant. Evidently, then, there is a mechanism apart from consciousness, apart from intelligence and the will, that brings about definite responsive movements under certain particular conditions.

Even in actions that are initiated and controlled by the mind there is much with which consciousness does not concern itself. Consider, for example, such an action as writing a letter. Intelligence is engaged with the subject-matter and with choosing fitting phrases to express it. The command to write is then issued, and forthwith the fingers grasp the pen and the point moves, forming the strokes into letters and the letters into words, without the slightest attention being paid to many of the great variety of movements that make up the whole action of writing. The action as a whole is under the direction of intelligence and will, for the hand writes what the mind directs, and writes it quickly, or slowly, or carefully, according as commands are issued. The single detailed movements that

go to make up the whole action, however, are performed automatically. The mind acts like the engine-driver who, to start his engine, pulls a lever and sets the whole machinery into motion of a most complicated yet harmonious character. In a way somewhat analogous intelligence determines the end to be attained, and the will gives the signal for the action to begin, whereupon the nervous and muscular machinery begins working and continues in an appropriate manner until the desired result is attained. Throughout the whole action, however, intelligence critically watches the work performed, and issues orders to augment, to lessen, or otherwise to modify the movements, and in this way keeps a general control over the movement as a whole. Any mistake or hesitation in a movement, too, immediately directs attention to the movement itself. Thus, to return to our example of writing, if the pen be clogged by a hair or splutters and scratches on the paper our thoughts are at once brought down from the higher flights of fancy to the more lowly and irritating task of overcoming mechanical difficulties. So long, however, as the action proceeds successfully and smoothly intelligence cares little about the mechanism of it. The important thing for consciousness is the result.

The Coordination of Muscular Movements.

Let us now carry our analysis into the details of each separate movement. In each individual movement in the act of writing many muscles of the fingers, hand, and wrist are brought into play. Some muscles are contracting, others relaxing. One set tends to counterbalance the other so as to secure greater delicacy and fineness of action. There is, however, a wonderful harmony in the coordination of all the muscular contractions and relaxations. Each muscle must contract, or relax, just at the right moment, for the appropriate length

of time, and with suitable intensity. The action of each separate muscle must fit harmoniously into the action of all the others, or confusion will result. The order and harmony in such movements as writing, carving, painting, walking, and talking is, indeed, wonderful. In the simplest of them the complexity of the coordination in the action of all the muscles is very great. In the continued action in writing a word, a sentence, and a letter the coordination becomes increasingly complex. When movements are successively combined into an activity lasting for a considerable period of time there is a series of ever-varying coordinations, of wonderful delicacy and harmony, in which the actions of the many separate muscles are simultaneously and serially combined together to produce the desired result. Such coordination of muscular movement is of still wider range in such an act as fencing, where there is not only coordination of the movements within a muscular group, but a coordination of the action of groups of muscles working together. Fingers, wrist, arm, shoulder, body, and legs are all engaged in making a stroke, in assisting its force, and in maintaining the equilibrium of the body.

Such coordination of movement, harmonious, without confusion or conflict in the play of the various muscles, is necessary at every moment of practical activity. It is seen in its highest form in such skilled actions as playing the piano, carving, and painting, but it is present to a greater or less extent in every piece of practical conduct.

Coordination of movement is not performed by intelligence, though in a general way it is under its guidance, and that in some detail if occasion requires. Coordination of movement is normally performed automatically through the action of the lower centres of the central nervous system; that is, by those centres of bodily

control in the spinal cord and brain the activity of which is not accompanied by consciousness. Though not directly concerned with intelligence and will these lower centres are, however, indirectly under their influence. For the original impulse to start the movement comes from the will, and similar impulses are continuously operating in the varied combining and modifying of movements which are the characteristic marks of intelligent action. However automatic may be the coordination of the elements of the action, yet in the integration of these elements to meet the varied circumstances of the environment intelligence and will find their place.

The Correlation of Sensory Stimuli and Motor Impulses.

The central nervous system, then, contains the mechanism by which the many and various orderly and harmonious movements of life are performed automatically, and also the mechanism by which such movements are combined and modified by intelligence to suit the varying situations of life. Such a nervous mechanism is the physical basis of skilled action.

So far only the motor aspect has been examined. Practical activity, however, has a dual aspect, a sensory as well as a motor. In all actions that are adapted to meet the varied circumstances of life movement is guided to its end by a series of perceptions. A skilled craftsman working in clay, wood, or stone cannot relax his attention. But his attention is not so much on the movements being made as on the material being manipulated and on the progress of the work. Eyes, fingers, and sense of movement supply a continual stream of impressions which his intelligence interprets as demands for this and that movement, and accordingly the movement is willed.

Practical activity, then, consists of a series of movements directed to an end by a series of perceptions. There

is a continual correlation of sense impressions and movements. Such correlation marks all skilled conduct, for only by such correlation can movement be appropriate to varying external conditions.[1]

The Nervous Organisation of Correlation and Co-ordination.

The work of correlating the action of senses and muscles and of coordinating movements of the muscles is performed by the central nervous system. Those elements in practical activity that are performed under the direction of the intelligence and the control of the will have their correlating and coordinating centres in the cerebral hemispheres. Those other elements that go on automatically have their correlating and coordinating centres in those parts of the brain and spinal cord the activity of which has no conscious accompaniment.

Part of the nervous organisation for correlating the action of senses and muscles, and for coordinating the movements of muscles is present at birth; it is a hereditary endowment, as witness such automatic action as sucking. Part develops as a hereditary endowment during growth, as in such actions as starting back from a blow or throwing out the arms in falling. The greater part, however, of the nervous organisation for skilled practical action has to be acquired by constant practice under the guidance of intelligence, directed by imitation and profiting by experience. The degree of perfection of such organisation is determined by the extent to which coordination of movements is perfectly harmonious and appropriate to securing the end in view and by the extent to which the mechanism of movement is correlated with the action of those senses that are most appropriate for guiding action. The basis of such coordination and correlation should become automatic, leaving intelligence free to work out higher and more complex

[1] *Cf.* Welton, *Principles of Teaching*, pp. 483-486.

combinations, and so to adapt conduct to the changing conditions of the external environment and to progressive ideals conceived by the intelligence.

The Organic Life of the Body.

3. The bodily machine besides containing the senses, the muscles, and the nervous system that correlates their action contains many other organs. The body must not only deal with its external environment; it must live. Hence there must be organs that minister to the vital needs of the tissues.

The life of every tissue consists in the building up of living substance from the nutrition and oxygen supplied by the blood stream, and in the continual destruction of living substance to supply the energy of life and work. All work—muscular, nervous, or glandular—performed by the tissues involves an expenditure of energy. This energy comes from the decomposition of the living substance, just as the energy of a steam-engine comes from the decomposition of the fuel. Living substance is the fuel of the energy of life and work. The decomposition of living substance, however, gives rise to certain simple substances, such as carbonic acid and urea, that from their action on the nervous and muscular tissues are harmful to life and functional activity. Blood fouled by an excess of urea or carbonic acid paralyses both muscle and nerve. These waste products, then, need to be removed from the system before their accumulation can result in harm.

Life is thus a dual process of building up and breaking down. Hence the organic system of the body must contain two sets of organs, those that subserve the building up of tissue and those that remove the waste products of tissue decomposition. Together these organs make up the digestive, respiratory, circulatory, and excretory systems.

The digestive system transforms the solid and liquid food taken through the mouth into such a form that it can

be absorbed by the blood. The air cells of the lungs permit the rapid passage at every breath of a large amount of the oxygen of the air into the blood surrounding the air cells. The blood, thus supplied with nutrition and oxygen, is forced by the heart—which is only a living pump—through a vast and extensive system of arteries and capillaries which ramify and penetrate every tissue of the body. Every tissue is thus bathed in a continuously flowing vital fluid, which parts with its nutrition and oxygen according to the demand of the tissues for these commodities. In this close contact with the tissues the blood receives from them the harmful waste products of decomposition, and carries them away to the excretory organs—the lungs, skin, and kidneys—which remove them from the blood and so keep it pure.

Healthy life and vigorous functioning of all the living organs will depend, then, on the power of the digestive, respiratory, circulatory, and excretory systems to satisfy the vital demands of those organs. Should digestive system or lungs fail in providing sufficient and suitable tissue-building material, or the blood be too poor and the circulation too feeble to carry nutrition and oxygen in sufficient quantities to the tissues, then both the life of the tissues and their power of performing their work will be enfeebled. Should the excretory systems—the lungs, skin, and kidneys—be unable to cope with the effects of tissue decomposition the blood will become fouled with waste products and every organ will feel the harmful paralysing consequences. Poor health or weak constitution means the feeble or faulty action of some one or other of the systems subserving organic life, and is followed by a weakening of vitality and a loss of power throughout the body. The body in such a condition is but an inefficient instrument for controlling its environment. The nervous

system is enfeebled. Work rapidly brings on fatigue and exhaustion. Muscular coordination is imperfect. Moreover, since the nervous tissue of the cerebral hemispheres is the seat of mental processes, intellectual and volitional power is weakened, memory becomes feeble, and there ensues a disinclination to mental exertion and a loss of self-control.

It has already been seen that the nervous system contains an organisation whereby the action of the senses and muscles is brought into harmonious correlation in carrying on the work of life with respect to external environment. Besides controlling this life the nervous system also governs the activity of the organs that administer to internal organic needs. Not only does the nervous system stimulate the life processes and the active functioning of the organic system, but it also regulates their activity according to the varying demands of the body. The need for nutrition and oxygen and for the removal of waste products varies with the activity of the tissues. When the nervous and muscular systems are in energetic action there is a large and continuous demand for tissue-building material to replace that destroyed. Rapid tissue-destruction, too, means an increasing need for rapid excretion of waste products. These demands must be met by a corresponding energetic action of the organs that subserve life processes. Such regulatory power lies in the central nervous system. Nerve centres exist that control the activity of respiration, circulation, digestion, and excretion in accordance with the varying needs of any organ or of the body as a whole.

The centres that regulate the life processes of the body, however, are not directly under the control of intelligence and will. Consciousness is mainly concerned with the intelligent adaptation of conduct to external conditions.

The machinery of organic life runs automatically like much of the machinery of movement. The nervous organisation of organic life is so attuned to the ordinary conditions of existence that the activity of each organ and the adaptation of that activity to the needs of the body proceed without conscious interference. Only when irregularities occur and the machine runs awkwardly do we become definitely aware of our organic life. Fatigue, physical pain, and disease force themselves upon consciousness. In good health the mind is hardly aware directly of what organs exist in the body.

The Organism as a Complex Machine.

4. The body, then, may be conceived as a complex machine of many organs, each having its definite work to do and each dependent on every other for its well-being. This community of organs is not, however, a republic, but a hierarchy having as its head the central nervous system. This system, by means of its nerves ramifying to and from every part of the body, regulates the action of each to the well-being of the whole, and so secures within limits the harmonious correlation of the action of all the organs to internal and external conditions. It constantly receives messages from each member and issues in response organised series of impulses to those parts of the machine that are best fitted to deal with the situation.

Many of the nerve centres are so organised and constituted that many of the outgoing impulses are issued as automatic responses to the incoming messages, and consciousness, even if it is aware of what is taking place, does not concern itself with coordinating the outgoing impulses and correlating them with the incoming ones.

On the other hand, many of the situations of life cannot be dealt with in this automatic, machine-like manner. It

is obvious that automatic machinery can only deal with conditions relatively fixed. Conduct that is adapted to the permanent welfare of the organism throughout life in an ever-changing environment demands an intelligence capable of rationally conceiving an ideal good and a will that can assert the claims of that ideal. An automatic machine acts blindly, and can only act well in the habitual conditions to which its organisation is attuned. Only intelligence and will can direct the behaviour of the organism through the changing scenes of life to ends that are remote and to a welfare ideally conceived.

Over all, then, is the mind controlling the organism by intelligence and will. Through the cerebrum, the seat of mind, it is brought into connexion with the organs of sense and movement, and thus into touch with the external world so as to know it and use it for its ends. Through the cerebrum, too, the mind is dependent on the body for its well-being, since the healthy and vigorous activity of the mind has for its basis the healthy and vigorous physical life of the cerebral hemispheres.

The Aim of Physical Education.

5. Having thus formed a conception of mind and body in their relation to each other, we are now in a position to define more fully the aim of physical education. Physical education, it has already been seen, seeks to fit the child for that practical aspect of life in which mental powers act in conjunction with physical powers in practical action. To this end there must be trained those qualities of intelligence and will and those powers of the body that will make practical action effective and successful in the co-operative and competitive work of life.

The first consideration of all is that the body as a body must have a sound and vigorous constitution. The nerves must be well nourished, the heart strong, and the

circulation vigorous, the blood pure and nourishing, the lungs sound and capacious, the digestion good, and the skin and kidneys energetic in action. A healthy and vigorous body is essential to a healthy and vigorous mind. A strong and active intellect, and a manly, confident, and courageous outlook on life mean at bottom a vigorous and healthy constitution. The old physicians, indeed, had some reason in their ascription of courage to the circulation of the blood.

(a) With Regard to the Body.

In the next place the body must be a capable instrument in the service of mind. The organs of sense and movement must be sound and serviceable tools. The eyes, as far as possible, must be good instruments for seeing, and the ears for hearing. The muscles must be strong and capable of resisting fatigue, the bones hard and firm, and the joints free and smooth in action. The senses and muscles, too, must be trained to work in harmonious correlation in skilled action. To sum up, we may say that health, strength, and skill are the virtues of the body as a serviceable instrument of mind.

(b) With Regard to the Mind.

The mind, however, is the controlling factor in the practical affairs of life, and certain qualities of intellect and character are requisite for success. In practical action a different quality of intelligence is needed from that demanded by theoretic study. In the classroom and study judgment should be calm, quiet, and deliberate. In the constant and frequently rapid change of conditions that practical life presents there is often, however, no time for calm and deliberate contemplation. There are rather demanded alertness of mind to seize on opportunities that once lost may never come again, keen insight and ready ingenuity to make the most of one's chances, coolness yet quickness of

judgment, and promptness of action. Life, too, always includes struggle with physical nature and with one's fellows. In this contest above all is required that power of self-reliance, independence, and self-assertion that does not readily admit defeat. The weakly in the physical and human battle of life must go to the wall. Success is to the strong—in character as well as in body. To face the battle of practical life needs self-confidence and courage, to pursue it strenuously demands hardihood and endurance to bear trials, and the issue calls for the power to master the self, to win without triumph, and to lose with a smile.

In many aspects competitive, in others life is co-operative, and here different qualities of intellect and character are demanded. In co-operative action each participant must play his part manfully and loyally, show a readiness to subordinate the self, exercise tact and sympathy in his dealings with others, and give cheerful obedience to law and constituted authority.

The Means of Physical Education.

6. The aim of physical education is thus seen to be a very complex one and to be more intimately bound up with intellectual and moral training ✓ than appears on the surface. Its end, so far as the body alone is concerned, is health, strength, and skill, but it seeks also to draw out, foster, and develop those qualities of intelligence and character that are required for effective and successful co-operative and competitive practical action. It is not by mere theoretic instruction in either hygiene or morals that this end can be attained. Contemplation of what is demanded by healthy, strong, and clean mental and bodily life is in no way a sufficient preparation for the active realisation of such a life. Nor is such contemplation the beginning but rather the end of training. The mental and bodily aptitudes required by a certain type of

life are only evolved by leading a life that encourages those aptitudes in a form suited to the immature though growing powers of boyhood and youth and leading up to the fuller and more vigorous practical life of manhood. The school life, then, must have a practical aspect. Its conditions of work must make for health and strength. Some of its pursuits must train skill. Above all, there must be occupations that call for free co-operation and competition in practical activities requiring strength, skill, intelligence, and spirit.

The pursuits and occupations of the physical aspect of school life must be tested by this criterion. (Exercises that merely develop health and strength, though good in themselves, cannot fully attain the desired end.) They must, if it is found advisable to include them, be subsidiary to pursuits and occupations demanding intelligence and spirit. Modelling, carving, and handicraft are good, since in them skill and intelligence are exercised in relation to aesthetic and practical ends. (Co-operative games and contests should be included, for they train not only health and strength but intelligence and character.) It is to a judicious combination of physical exercises, manual crafts, contests, and games that the problem of physical education must look for its fullest and truest solution.

CHAPTER III.

THE PHYSICAL BASIS OF LIFE.

The Energy of Life and Movement.

1. The body is a very complex machine whose function is to do work in the physical world in adapting itself to its surroundings and its surroundings to its own needs. Every movement of the body, the constant inhaling and exhaling of air, the continual flow of blood, and the replacement of the heat lost by radiation involve a continuous expenditure of bodily energy. Such energy is derived directly from the working tissues, which in turn have stored it from the nutriment of the blood, and the blood in its turn has taken it from the food and oxygen of the external world. The tissues in action undergo a constant diminution of their stock of energy which is replenished during rest. The body, then, may be regarded as a machine for transforming the energy of food into the energy of life and work, just as a locomotive is a machine for transforming the energy of coal into the energy of motion. Such a simile holds in broad outline, for it is by the combustion of the coal into carbonic acid and water that heat is given off and ultimately work is done, though the details of the two processes are vastly different from each other. Ultimately the work done by the bodily machine is due to the decomposition of the food into simpler products such as carbonic acid, water, and urea. The matter and energy of the food, however, go

through many transformations in different parts of the body before the simpler substances such as carbonic acid, urea, and water are passed off from the body, and before the energy of the food appears as bodily heat and work.

Transformation of Matter and Energy.

Though different from a mechanical machine the body is like one in that in its physical life it accords with the laws of physical science. Science assumes that the sum total of matter and energy in the universe is constant: matter and energy, it asserts, cannot be destroyed. Under changing conditions each may change its form, but in the transformation from one form to another none is either lost or gained. The solid coal, that to superficial observation disappears as it burns in the furnace of the locomotive, is simply turned into gaseous vapours, and if all these vapours could be collected their weight would be found to be greater than the weight of the coal by the weight of oxygen taken from the air by the coal in burning. The energy of the moving train and of the heated and expanding steam also comes from the energy stored in the coal. By burning, the pent-up energy of the coal is released and appears as the energy of heat and motion. For energy may take many forms, such as heat, chemical force, electricity, mechanical motion, and cohesion.

Potential and Kinetic Energy.

The energy of coal, however, is obviously very different from the energy of the moving train, just as the energy represented by a weight placed on a table is different from the energy represented by the same weight falling to the floor. The moving train and the falling weight are clearly doing work. Energy is in the act of changing its form. But the energy of a lump of coal is not of this active kind. While the coal remains a lump of coal no work is being done. There is, however, the potentiality of work.

But as long as changing conditions do not alter the state of the coal its energy will remain in the static form. Only when the state of the coal is altered will its *potential* energy change to an active *kinetic* form and work be done.

Chemical Energy.

When a weight is lifted from the floor to a table, work is done on the weight which can be exactly recovered by allowing the weight to fall from the table to its original position. The weight while on the table represents a store of energy—energy due to the position of the weight. In the same way the energy in coal is energy due to position; not, however, to the position of coal in the mass, but to the position of its component elements relative to each other.

Coal, as all know, is made up of extremely small particles called molecules, which in turn are composed of a number of still more elementary bodies called atoms. When the coal changes its form, as in burning, the atoms are merely rearranging themselves and, with the atoms of the oxygen of the air, are forming different kinds of molecules. Every chemical change is merely a rearrangement of atoms, in which none are destroyed and none are formed. Molecules may change their form, become decomposed, and new molecules be built up, but the elements of which the molecules are formed do not change. They simply rearrange themselves.

In this rearrangement, however, energy is also changing its form. The arrangement of atoms in the molecules of the coal represents a fund of energy. When the coal is burning the atoms of the coal and those of the oxygen of the air rearrange themselves into molecules of carbonic acid and water, but in the change some of the energy of the coal appears as heat and as the motion of expanding gases. There is, however, an exact debit and credit account. The energy of heat and motion expresses just the difference between the energy of the coal and the oxygen of the air

and the energy of the resultant products of the combustion of these bodies. If carbonic acid and water were to be changed back to coal and oxygen, exactly the same amount of energy would have to be supplied to them as was given out in the reverse process of turning coal and oxygen into carbonic acid and water.

A molecule of coal, then, has in a potential form more energy than have the molecules of carbonic acid and water that result from the decomposition of the coal. It may be said, therefore, that coal has high potential energy in comparison with the energy of carbonic acid and water. Bodies composed of molecules of a more or less unstable character usually have relatively high potential energy. The atoms constituting the molecules of such substances easily tend to rearrange themselves, and in the change energy is given off in the form of heat or motion. On the other hand, bodies of a stable character have usually low potential energy. The atoms composing their molecules rearrange themselves with difficulty, and, when they enter into chemical changes, energy frequently is absorbed rather than given out in forming the new molecules. Nitroglycerine, oils, coal, and food substances are bodies of the former kind, whilst water, carbonic acid, and urea are substances of the latter type.

Food the Source of Bodily Energy.

The body, as has been said, is a machine for transforming the matter of food into living tissue, and its energy into the energy of life and work. The food supplied is the source of all increases in living substance. All growth is due to the nourishment supplied to the tissues by the blood, which contains the transformed food that enters the mouth. On the other hand, all decrease of weight is due to the excess of the excreted waste products over the nourishment absorbed into the system. The body

is using up its living tissue faster than this is being replenished by the food.

The various food-stuffs are substances of relatively high potential energy. They undergo many changes in the digestive system before being absorbed into the blood. Still further changes take place when the nutrition of the blood is built up into living tissue. Finally, however, the matter of the food reappears in the form of waste products, such as carbonic acid, water, and urea, which are excreted from the body. These bodies have low potential energy. The difference in energy has been consumed in heating the body and in the performance of the tasks of breathing, circulation of the blood, and muscular movement. The energy of life and movement has its source entirely in the oxygen we breathe and the food we digest. How the body transforms the food and oxygen into living tissue and its energy into heat and motion is another question, to answer which something must be known of the structure of living substance.

The Body a Community of Living Cells.

2. Microscopic examination shows that the tissues and organs of the body are collections of bodies of extremely small size called cells. Every living plant and animal, however small or large it be, has this cellular structure. Many plants and animals consist of only one cell. Such is the amoeba. Its single cell performs in itself all the offices of life. It inhales oxygen, takes in food, secretes digestive fluids, excretes indigestible particles, responds by movement to the stimuli of its environment, and performs every kind of life process.

Higher types of animal and plant life are really communities of cells joined together to form a single individual. As in a community of men and women, there are in such forms differentiation and centralisation of function. Each

particular form of life activity is carried on by special cells grouped into organs. The work of movement, for example, is confined to the muscle cells, which are brought together into solid masses to form the muscular framework of the body. The work of secretion is peculiar to glandular cells grouped together into organs. The salivary glands of the mouth, the gastric glands of the stomach, the liver, and the sweat glands of the skin are constructed of cells whose special function is to absorb certain substances from the blood.

The more physiology penetrates into the mystery of animal life the more it is forced to the conclusion that the various activities of the organs of the body can only be explained by an intimate knowlege of the life and action of the separate cells composing these organs. The activities of the body, as they appear to us in the beating of the heart, in the inspiration and expiration of breath, in the movement of the limbs, in nervous conduction and control, in the action of the sense organs, are the mass effects of organs acting as wholes. Each of these activities, however, is but the aggregated effects of the action of many cells of the same and of different kinds working in harmony, and its explanation is only to be found in the study of the life processes and of the special functional activity of each kind of cell. The explanation, for example, of such a movement as coughing or sneezing is to be sought in a knowledge of the different processes going on in the cells experiencing the irritant stimulus, in the muscle cells contracting and relaxing in response, and in the nerve cells that bring these two classes of cells into correlation.

Whether a cell be a free, living, independent, organism like the amoeba, or a member of a cell community as those that compose the organs of a human being, the funda-

mental life processes are, in the main, the same. Each cell has to live, and to live it must absorb food and oxygen, build these into living substance, and excrete the waste products which result from its life and work. Whatever be the cell —muscle, sense, nerve, or gland cell—these vital activities are fundamental and essential to its life and to its special work. The muscle cell cannot contract nor the nerve cell originate nerve-stimulus without also performing the vital processes of respiring, absorbing food, building up living tissue, and excreting waste products. Thus, in the specialisation that cell life and activity exhibit in cell communities the cells do not lose the essential vital characteristics of cell life. Each kind of cell simply develops to an extreme some one form of possible cell activity. In one case it is contraction, in another secretion, and it is this special form of activity that gives to each cell its peculiar function and name.

Structure of the Cell.

3. The cell, then, is the physiological unit. To grasp the vital processes and the special activity of the various cells of the human body in their relation to each other is to understand how the human machine lives and does its work. Cells are microscopic bits of living substances, called *protoplasm*, which is sometimes surrounded by a cell wall and sometimes not. Contained in the protoplasm is a body, called the *nucleus*, of greater refractive power, which, therefore, appears darker when seen through the microscope. Embodied in the interstices of the protoplasm may be various other substances, as oil droplets, starch grains, glycogen,[1] pigment grains, and granular bodies of various kinds.

Though never larger than a few millimetres in diameter, the cells have a variety of shapes. Some, like the amoeba and the white corpuscles of the blood, possess no

[1] A form of starch.

constant shape, and change their form from minute to minute. Those enclosed by a cell membrane have of necessity a definite shape. The usual form is polyhedral, like the chambers of a honeycomb. Cells of this shape are found in the skin and in the various glands. It is a shape most convenient for the close packing of many cells in small space. There are many cells, however, whose shape diverges widely from the polyhedral form. Nerve cells, for example, have very irregular shapes, and send out numerous branching processes from their main bodies. The cells of muscles are enormously elongated, so that they give the appearance of long slender spindles.

The living cell contains a liquid of a semi-viscous character like the raw white of an egg, though its consistency may vary from that of a watery liquid to that of a stiff jelly. This is the living substance. Besides this, however, the cell almost always contains other substances that are not living, but are of great importance in its life. These are: (1) food substances on their way to being built up into living tissue, (2) substances that have been formed by the vital processes going on in the cell, as fat droplets and glycogen, (3) waste products of the life and functional activity of the cell waiting to be exuded, as creatin and lactic acid.

Life Processes of the Cells.

4. In every cell, then, is to be found both living and non-living substances, and it is important to grasp the physical difference between the one kind of matter and the other. Living substance is composed of the same elements as are found in non-living matter. Carbon, hydrogen, oxygen, and nitrogen are its main ingredients, and sulphur, phosphorus, calcium, and sodium are present in lesser quantities. The great size and the complexity of the molecule of living substances, however, are very striking

features. Though comparatively few elements enter into its construction, yet the number of atoms of those elements and the complexity and the variety of their arrangement within the molecule are very great. It is to these qualities of the molecules that their instability is mainly due. The number of atoms and the complexity of their arrangement make many rearrangements an easy matter. Living matter, as everyone knows, readily decomposes into simpler substances.

Nor are the chemical changes that continually take place in living protoplasm different in character from those that are to be found in the inorganic world. Molecules are broken up, and atoms rearrange themselves into new molecules, in living tissue, according to the action of the same kind of physical forces that are operative in changes in non-living matter. In the perpetual rearranging of atoms that goes on in living substance energy is constantly changing its form. Potential and passive in its form in living substances it appears as heat and motion on the resolution of the tissue into waste products, and every change is in strict accord with the fundamental laws that govern physical and chemical changes in the non-living world.

The peculiar property of living substance, however—the quality that marks it as living—is its power of continually absorbing into itself new substances from the bodies that surround it, of building these substances into its own constitution, and of as continually decomposing and giving off waste products. Perpetual change is the mark of the molecules of living tissue, which must be regarded as having no fixed and definite constitution. The living molecule exists in a state of continual flux. Surrounded by the blood fluid which bathes the cells of all the tissues, it is continually entering into combination with

groups of atoms taken from the nutritive fluid, and building itself into an increasingly higher state of complexity. At the same time the atoms within the molecules are as continually undergoing rearrangement, and groups of atoms are broken off. The nutriment and oxygen of the blood are, then, not merely absorbed into the cell; they enter into chemical union with the atoms of the living protoplasm and become part of the living tissue; the waste products are the result of the decomposition of the molecules of living substance.

In the continual rearrangement of the atoms of the molecules of living substance, either in the elaboration of the food and oxygen into living tissue or in the decomposition of living tissue into waste products, many substances are formed which accumulate in the cell and may be called *by-products* of cell activity. Some of these by-products are stored in the cell for future use and may at some time be absorbed again by the living tissue or by the blood. They thus act as reserves of nutrition. The glycogen formed by the liver cells and the fatty globules present in nearly all cells are of this kind.

Other of the by-products may be exuded from the cell and deposited round it as a framework. In this way hard supporting structures like bone and cartilage are built up.

Still other of the by-products are used in the economy of the body. The various digestive juices belong to this class. The saliva formed by the protoplasmic activity of the cells of the salivary glands, and the gastric juice formed by the cells lining the walls of the stomach, have as their work the digestion of food substances.

The final products of tissue decomposition are of no further use and are indeed harmful to cell life. It is, therefore, necessary for them to be excreted from the body before their accumulation leads to harmful consequences

The most important of the waste products are carbonic acid, urea, water, and lactic acid, the last being a substance that is also found in sour milk.

It is seen, then, that the living cell manufactures many kinds of substances from the blood that bathes its surface. Some act as reserve foods, some are used in the framework of the body, some are necessary to the bodily economy, while some are harmful and must be got rid of. All, however, are the result of the ceaseless changes taking place in the living tissue. Some are formed in the ascending stage, when food is being built up into living substance; others in the descending stage, when living substance is undergoing decomposition; others may never have been part of the living substance at all, but formed as remainder products from the action of the living substance on the food.

Influence of Stimuli on the Activity of Cells.

5. We have now traced in main outline the essential features of the vital processes of all living cells, whether they be muscle, gland, nerve, or sensory cells. Each particular kind of cell has its own form of living tissue which undergoes changes peculiar to itself, but all are alike in that the molecules of their protoplasm are in a state of continual flux, building themselves up from the food and oxygen of the blood, decomposing into waste products, and forming by-products.

This building up and breaking down, assimilation and dissimilation, or to give one name to the dual process, *metabolism*, is the essential activity of life regarded in its physical aspect. However the cell behaves—changing its form as in the muscle cell when it contracts, secreting ferments as in the digestive gland cells, storing glycogen as in the liver cells, excreting waste products as in the sweat glands of the skin, receiving stimuli from the

external world as in the cells of sense organs, transmitting impulses from one part of the body to another as in the nerve cells—its behaviour is an expression of the metabolic activity of the living substance of the cell. The explanation of the nature of the life of the cell and of its particular functional activity is to be found only in the kind of changes that are taking place in its living tissue, continually and ceaselessly in the case of the vital processes, under special conditions when the cell is performing its particular function.

A cell performs its special function only when stimulated to do so by conditions external to itself. Functional activity is, therefore, a response to something acting on the cell. The stimulus acting may be physical forces in the external world, or may be changes in the nature or flow of the blood bathing a cell, or may be the direct action of one cell upon another with which it is in connexion.

Naturally the cells facing the external world are liable to have their metabolism modified by forces acting on the world outside. Waves of light, vibrations of sound, contact with other bodies, heat and cold, all have their first effect on the body in modifying the metabolic activity of the cells in the eye, ear, skin and membranes of the nose and palate. The modified activity in the sensory cells acts as a stimulus to the processes of nerve cells in contact with them, and these in consequence have their cell activity modified. From nerve cell to nerve cell the stimulus passes, spreading itself over the nervous system as a wave of modified protoplasmic activity, especially in those directions where the connexions between the nerve cells are the most close and intimate. Finally it may pass from the nerve cells to muscle cells or gland cells, causing alterations in their tissue life and giving rise to contraction or secretion.

In the passage of the stimulus, however, from sensory cell to muscle or gland cell there has been no conveyance of energy from one part of the body to another. Each cell is its own storehouse of energy, and, according to the influences at work upon it, is either increasing or expending its own energy by an altered metabolism. There is only a conduction of stimulus by which changes occurring in one kind of cell produce changes it may be of a very different character in other cells.

Cell activity is naturally very dependent on the nature of the blood that supplies it with the means for its metabolic changes. Any change in the amount or character of the blood is likely to produce very considerable modification in the way the cell functions. An increase in the flow of blood through an organ stimulates the vital processes of the cells. Tissue changes, therefore, take place more rapidly, and their effect is seen in more vigorous life and enhanced functional power. For example, if the circulation of blood through the brain be increased, the nerve cells are stimulated to more vigorous life and brighter spirits and keener mental power result. On the other hand, if the flow of blood through the brain be, for a few moments, reduced by pressure on the carotid artery in the neck, consciousness is lost, showing that there is considerable modification in the metabolic activity of the living substance of the nerve cells. Similarly, fainting is frequently caused by a sudden cessation or weakening of the heart's action.

The quality, no less than the quantity, of the blood bathing the cells has a great effect on cell metabolism. After a hearty meal the blood is surcharged with nutritive substances, and this excess stimulates all the cells of the body to increased tissue changes. This is shown by the fact that after a meal there is a considerable increase in the quantity

of waste products excreted. An excess of nutrition in the blood, too, stimulates the cells of the liver and of the muscles to manufacture reserve products which they store up in the form of glycogen or animal starch. Should the blood fall below its normal standard, however, the reverse action of the liver and muscle cells parting with their reserves to enrich the blood is exhibited. In the same way many cells are stimulated to manufacture fat, or to part with it, according to the excess or defect of nutrition in the blood.

The waste products of tissue life and work have a considerable influence on cell activity. Their action is harmful in that they reduce metabolic activity, and, if they be present in more than certain proportions, paralyse it altogether. The reduced mental power and force of will, the feelings of languor and inertness, that are the mental signs of a state of bodily fatigue, are examples of the action of waste products. The waste products derived from the vigorous and prolonged activity of nervous or muscular tissue, accumulating in the blood, act on the nerve cells of the cerebral hemispheres, and the modified activity of these cells is seen in the mental signs of fatigue.

It is evident, then, that in considering the healthy life and active functioning of the organs of the body two kinds of influences have constantly to be kept in mind. In the first place, the quality of the blood and the vigour of its circulation have an important bearing on health and power. It will be the work of later chapters to show how good nourishment and fresh air—the sources of cell energy, appropriate exercise to stimulate circulation, respiration, and excretion, and rest, sleep, and relaxation to encourage recuperation, are essential to healthy life and growth. In the second place, the condition of the nervous system has

an important influence on organised action. In the work of life, senses and muscles must work together in harmonious action, and, as we have seen, the correlation of their activity and the coordination of movement is performed through the medium of the nerve cells that bind senses and muscles into one organic system. Later chapters will show that the nature of the nervous connexions between senses and muscles determines the degree of skill with which the organism can attain its ends in the physical world.

Unifying Function of the Nerve Cells.

6. The human organism is a vast collection of cells, each of which lives its own life. Yet each lives its life in thorough dependence on the activity of all the others. For the collection of cells constitutes a single individual that lives and acts as a whole. Hence, though each cell has its own life, yet each cell has apportioned to it some special function by which it contributes its quota to the life and work of the individual. The life of the organism as an individual is not the aggregation of the lives of its component cells, but the harmonious integration of the special activities of the various groups of cells.

Such an individual life of a collection of cells would not be possible without some central governing and controlling power by which the special activities of all the groups of cells are subordinated to the welfare of the whole. Such a power is exercised by the cells of the nervous system. The nerve cells of the brain and spinal cord, by their thread-like processes that ramify through the body, bring every cell directly or indirectly into connexion with every other cell. The function of these special cells is to transmit stimuli, so that conditions affecting one group of cells may influence the activity of groups of cells widely distant. The cells of the nervous system thus bind the community of cells into a single individual,

and, by their means, the individual can act as a whole with respect to its external environment or its inward needs. Without such a unifying system the response to stimuli would be confined solely to the cells directly affected, whereas by the connecting links of nerve cells external or internal conditions affecting one group of cells may be responded to by the organism as a whole.

One group of nerve cells stands out pre-eminently above all the others as having the widest and most extensive control over the organism throughout life. These highly specialised cells are those whose activity is accompanied by consciousness. They are, directly or indirectly, in connexion with all the groups of cells of the body, and especially with those whose peculiar function is to receive external stimuli and with those that execute movements. Hence, in particular, does this group of cells exercise a control over the behaviour of the organism with respect to its external environment. By means of the activity of consciousness the organism can know its present circumstances, make use of its past experience, and determine its future welfare. Hence through consciousness the organism ceases to be the mere sport and plaything of its environment. In accordance with its idea of its own welfare, it can adapt itself consciously to its environment, or its environment to its own needs. Clearly, then, consciousness gives the organism still further unity, an added power to act as a single individual throughout life, for by consciousness unity of purpose and of action becomes possible over long periods of time.

These highly specialised cells, however, do not differ in the physical aspect of their life and activity from those of any other cells of the organism. They absorb nutrition and oxygen, build up new living tissue, and excrete waste products. Their special activity is, on its physical side, only

the modification of protoplasmic metabolism. Their health and power are dependent on the vigour of the circulation and the character of the blood. Good nourishment, fresh air, and vigorous circulation stimulate them to enhanced activity, which shows itself, in the mental side of the life of these cells, in higher spirits and increased mental power. On the other hand, poor food, foul air, stagnant circulation, and anaemic blood diminish the activity of these cells, and irritation and a weakening of mental power result.

The health and vigour of conscious life are thus reflexes of the physical health and vigour of these highly specialised nerve cells, and their life and activity in turn depend on the healthy life and the harmonious and vigorous activity of all the other cells of the organism.

CHAPTER IV.

THE NERVOUS SYSTEM.

The Nerve Cell or Neurone the Unit of Nervous Organisation.

1. The last chapter showed that the body is a community of cells in which there is specialisation and centralisation of function. Groups of cells, collected together into organs, are specially adapted to the performance of particular kinds of work. The whole is brought into harmonious relation to inward needs and external conditions by the mass of nervous tissue called the Nervous System.

The essential work of the nervous system was seen to be that of correlating the various activities of the different parts of the organism. Nerve currents pass continually from the sense organs, the muscles, and all the various tissues to the central nerve centres, and impulses coordinated in an orderly manner are sent to the muscles, heart, lungs, arteries, glands, and other organs to stimulate them to an activity adapted to the conditions that originated the initial impulses.

Our next step is to consider the structure of the nerve tissue and its organisation, and to discover how these are adapted to perform that supreme work of correlation and coordination on which the orderly life and functioning of the whole organism depend.

The physiological unit of body tissue is the cell, and the nerve cell is the unit of the nervous system. Its structure is specially suited to the work of bringing distant parts of the body into relation with each other, so that excitations arising in one part may influence many widely distant parts.

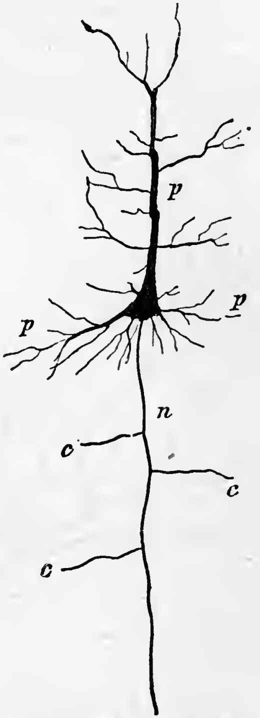

Fig. 1.—PYRAMIDAL CELL FROM THE CEREBRAL CORTEX, STAINED BY THE SILVER METHOD. (After Ramon Y. Cajal.

pp, Dendrites; *n*, Nerve Fibre; *cc*, Collateral Branchings of the Nerve Fibre.

Copied from Wundt: *Principles of Physiological Psychology.* (Sonnenschein.)

The Nerve Fibre.

The distinctive feature of the nerve cell is the prolongation of its protoplasm into numerous branching, thread-life 'processes.' One such process in each cell is distinct in structure, and probably in function, from all the others; it is called the *nerve fibre* or *axis cylinder*. At intervals the nerve fibre sends out lateral branches, and both fibre and branches end in branching 'fibrils,' *i.e.* little fibres, of extreme delicacy. The nerve fibres of the cells vary in length. Some are very short; others very long, stretching in some cases from the brain to the bottom of the spinal cord, or from the cord to the ends of the limbs.

The other processes, called *dendrites*, radiate from the

cell in all directions and are marked by an immensity of branching ramifications. So frequent and intertwining, and so delicately fine is the branching of the dendrites and the endings of the nerve

Dendrites.

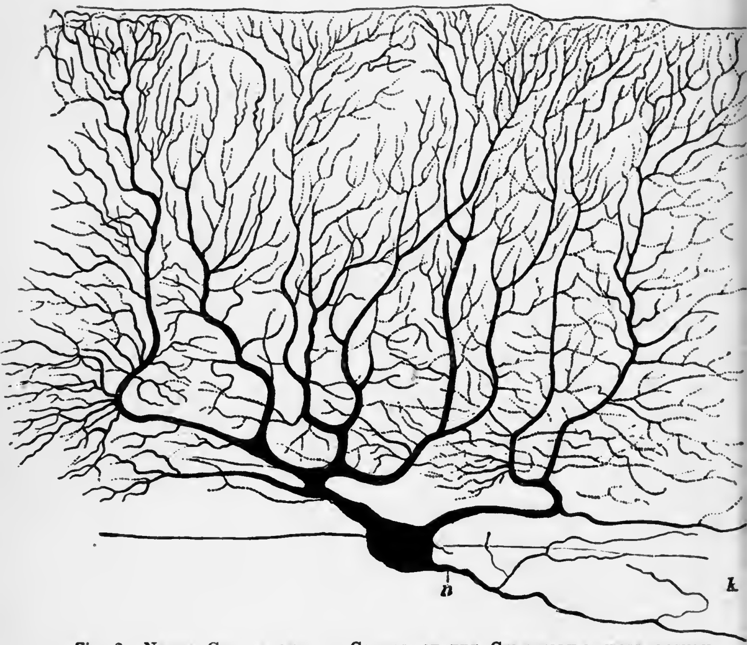

Fig. 2.—Nerve Cell from the Cortex of the Cerebellum, with richly branching Dendrites. (After Köllicker).
n, Nerve Fibre; *k*, Collateral Branches.
Copied from Wundt: *Principles of Physiological Psychology.* (Sonnenschein.)

fibres that, in the central system, the cell bodies seem to be embedded in a continuous fibrous network that knits the whole into a compact organ, from which issue collections of fibres, called the nerves, going to various parts of the body.

The Cell Body. The living substance from which the processes arise is sometimes spoken of as the nerve cell, but more correctly as the cell body. It must, however, be clearly grasped that the processes are as vital a part of the cell as the cell body itself, and are simply a prolongation of its living substance. Sometimes, indeed, the nerve fibre is so long, and the dendritic processes so numerous and branching, that the substance of the processes far outweighs the substance of the cell body. It is convenient, therefore, to avoid confusion, and to fix the idea that the cell body with its nerve fibre and dendrites constitutes a nerve unit, to speak of the whole as a *neurone*.

Most of the cell bodies are grouped together in the brain and spinal cord, and from these centralised masses bands of nerve fibres pass to the various organs. This arrangement accounts for the marked difference in the appearance of the central system from that of the nerves. The nerves are distinctly white in colour, owing to each fibre being surrounded by a white sheath called the *medulla*. The cell bodies and the network of fibrillar processes have no such sheath, and, being plentifully supplied with blood capillaries, present a pinkish grey appearance. In the central system—the brain and the spinal cord—both white and grey nervous tissue are to be seen; there are pinkish grey territories, where cell bodies are massed in a network of interlacing fibrils, and columns and strands of white matter, where bands of white fibres connect one part with another.

The Nervous System a Complex Organisation of Neurones. 2. The nervous system consists of an immense number of neurones varying both in size of cell body and processes and in the extent of their branching dendrites. In such a vast collection it is only natural to expect differentiation and specialisation of function. By means of their nerve fibres some neurones are attached to the cells

of sense organs, some to the cells of muscles, some to the cells of glands; other neurones serve simply as connecting links between different groups of neurones. The cell bodies attached to the sense organs are open to stimuli travelling inward along the nerve fibres. Those attached to muscles or to glands originate impulses which travel outward, controlling the action of those end organs. Hence the former kind of neurone is termed *afferent* or *sensory*, and the latter *efferent* or *motor*, while the third class, which serve as connecting links, are termed *intercalary* neurones.

The structure of a single neurone is fairly simple, but it is impossible for the mind to picture in any detail the complexity and intricacy of the arrangement and organisation of the vast number of neurones composing the human nervous system. Knowledge of this arrangement is very far from complete, and it will be sufficient for our purpose to set forth a broad outline without endeavouring to fill in the details of the complex organisation.

The branching processes play a most important part in organising the neurones into a united system. Their function is to bring each neurone into intimate relation with many other neurones. Through such connexions an excitation passing along one neurone can stimulate to action many other neurones passing to distant and diverse parts. Thus conditions affecting one part of the body may through a chain of connecting neurones call out responses in various parts of the body. For example, the neurones controlling the action of a muscle are by their ramifying dendrites open to excitations from many directions. A pin prick, an object seen, heard, tasted, or smelled, an impulse originating in the cerebrum, each may cause the same muscle to function. The efferent neurones directly attached to muscles or glands serve, by means of the many connexions established by the branching

dendritic processes, as common paths for excitations arising in very various and distant parts.

On the other hand, a sensory stimulus passing inward may discharge itself along many paths. The excitation caused by a pin prick ultimately reaches many destinations either by direct or by roundabout paths. We have a consciousness of pain, we utter sounds, we withdraw the limb affected, we may even in severe cases stamp our feet and contort our bodies, we hold our breath, the heart-beat is affected. The incoming stimulus travelling along the afferent fibres reaches the central system and spreads itself out, by means of the various connexions established by the branching processes, in many diverse paths. Of course, the wave does not travel indiscriminately over the whole system. It can only travel where connexions are established, and it travels most easily along those paths where the connexions are most close and intimate, and where there is, consequently, least resistance to conduction. It is natural to expect, then, that the stronger the stimulus the more widely will the wave spread over the various paths open to it. A stimulus of weak intensity will cause a slight response, as when the eye blinks to a ray of sunlight or the head turns to a slight noise. A bright intense flash of lightning and a loud clap of thunder may, however, cause violent starting and trembling of the whole body and even in some cases general convulsions.

Excitatory and Inhibitory Impulses.

3. A stimulus that induces activity in a neurone can cause excitations of two distinct kinds in the living protoplasm of the nerve cell. Cell life, it has been seen, consists of combined ascending and descending metabolism of the molecules of the living substance. There is a building up and a breaking down of the molecules. Ordinarily the two balance each other, so that, in the

cell as a whole there is equilibrium. As much energy is being stored up as is given off. Stimuli acting on the cell can, however, influence this metabolic activity in two ways. They may cause an increase in the building up process, *i.e.* in the storing up of energy, or an increase in the breaking down process, *i.e.* in the giving out of energy. Whichever of the two processes any given stimulus influences we may expect its effect to be of an opposite character to that of the other. If the one results in the contraction of muscle or in gland secretion, the other will tend to produce inhibition of movement or secretion.

That two kinds of nerve impulses, one of an excitatory character, the other inhibitory, can be generated is easily illustrated. Almost all cases of restraint of such instinctive movements as coughing, sneezing, starting at sudden sounds, and subduing emotional expression are instances in which inhibitory impulses wholly or partially overcome impulses to movement. Both kinds of nervous impulse are exemplified in muscular movement. Every movement is executed by the harmonious action of two sets of muscles, the flexors and the extensors. One set bends a limb on itself, the other straightens the limb out. When one set contracts, the other relaxes. So that in a complex movement a series of waves of impulses is proceeding to the muscle group, causing at one moment certain muscles to contract and others to relax, and at another moment the former to relax and the latter to contract. The waves proceeding to the muscles are thus coordinated series of excitatory and inhibitory impulses. One set produces contraction, the other relaxation.

We must imagine, then, that every afferent stimulus influences many sets of neurones according to the connexions that exist, and spreads itself out over many paths, in some as an excitatory impulse, in others as an inhibitory

one. Since many such stimuli are passing inward from the sense organs every moment, it is easy to understand that the same set of neurones may be influenced by stimuli from two or more different quarters. Impulses, in that case, will interfere with each other. Those of the same character, by combining in their action, will produce an increased effect: those of opposite character will neutralise each other. The former case is exemplified when both the sight and the smell of an object lead to the action of grasping it; the latter is seen when we force ourselves to touch an unpleasant surface or to swallow a distasteful draught.

Nerve Centres.

4. The nervous system, it has been seen, has the supreme function of correlating and coordinating the action of the many organs of the body. It is natural to expect, then, that the junctions between the various sets of neurones from the organs of the body are important places for the correlating and coordinating of nervous excitations. The junctions of sets of neurones are called *centres.* They usually consist of collections of cell bodies with their interlacing dendritic processes. Connexions with other sets of neurones are made by the latter, which mingle with the branching endings of the fibres of other neurones.

The centres, however, are more than mere junctions. To borrow an analogy from the telephone, they are receiving and transmitting stations for the control of the activities of definite bodily areas. Messages are received along the incoming neurones, and appropriate orders are transmitted along the outgoing neurones to the end organs. We must not, however, regard the neurones as mere conductors of nerve currents, nor think that an incoming current is merely deflected at a centre into an outgoing one. An excitation in one neurone *induces* excitations in those neurones that are in connexion with it.

At a centre, then, where many neurones are brought into connexion, the incoming excitation will induce outgoing waves in those neurones that radiate from the centre. Some of these waves may be inhibitory, others excitatory, according to the character of the initial wave, the nature of the connexion, and the state of the neurones. For example, when the hand is withdrawn from a pin prick there are sent out from the centre controlling the action both inhibitory and excitatory impulses that cause some muscles to contract and others to relax. Usually the resulting movement is an action appropriate to the circumstances that initiated the incoming stimulus, as in the case of coughing or sneezing when the nose or throat is irritated, or when, in willing the hand to write, appropriate movements of grasping the pen and making definite marks on the paper result. The outgoing waves to the muscles are definitely coordinated in a perfectly orderly manner so as to produce the movement required.

Thus, a nerve centre contains the organisation for adaptive action. It not only controls the activity of certain parts of the body, but controls it so as to produce definite actions appropriate to the circumstances that initiate the incoming stimuli.

The Different Orders of Nerve Centres.

5. The activity of the body, then, is controlled from the nerve centres. The correlation of the activity of the organs, however, presents very different degrees of complexity. On the one hand, such simple actions as blinking the eye in response to a flash of light exhibit a relatively low degree of correlation. On the other, an artistic performance on the violin, where the movements vary from moment to moment and yet the whole action is a harmonious and artistic unity, shows a correlation of a vastly higher and more complex nature. We may, then, expect to

find in the nervous system different orders of centres for controlling actions of different degrees of complexity.

Centres for Simple Reflex Action.

The simplest form of nerve centre is seen in those centres that control such simple instinctive actions as sneezing, coughing, blinking, and withdrawing the hand or foot from a noxious object. Such actions are termed *reflex*, because the incoming stimulus, at first sight, appears to be deflected, or reflected, at the centre into an outgoing impulse. The action, however, is not so simple as mere reflexion. The centre contains some form of organising machinery. The afferent neurones are in such relation to the efferent neurones that incoming stimuli induce a coordinated series of excitatory and inhibitory impulses that result in an action of a definite kind.

Such actions as these are usually very localised in their character, and are not the response of the organism acting as a whole. Blinking, sneezing, and coughing are certainly not general responses of the whole body. In each case the action is confined to a very limited group of muscles which responds to a stimulus of a strictly local and definite character. It is not, then, remarkable that actions of this kind take place, to a large extent, independently of the intelligence and the will, since the function of the mind is rather to deal with the welfare of the organism as a whole than with the separate and independent needs of one part. No doubt, as a rule, the mind is aware of what is going on. In sneezing, for example, we are only too painfully conscious of the irritation of the membrane of the nasal passage and of the violent exertions of the respiratory machinery to effect a cure. Yet we do not will the sneeze; we may rather be said merely to witness and suffer it. The centres for this kind of simple reflex action, then, are largely independent of the centres of intelligence and will.

But they are not wholly independent. Though we frequently fail entirely to check sneezing and coughing, yet many of the local reflex actions are lessened in intensity and modified in character by the supervising action of the higher centres of voluntary action. Much of good manners consists in the strict voluntary control of emotional expressions of a reflex character. Society demands that the young be trained to preserve a calm exterior whatever be the agitation within. In such cases the centres of voluntary control seek to inhibit the excitatory impulses flowing from the simpler and more local centres controlling limited areas of the body.

Centres for Complex Automatic Action.

These centres of reflex action are examples of the simplest form of nerve centre. Those that govern more complicated actions, such as walking, talking, and fencing, are much more complex. Such movements, though largely automatic in character, are not confined to one local group of muscles, but involve the concerted action of many groups in various parts of the body. The organism, in such actions, acts as a whole. In fencing, for example, not only are the muscles of the fingers, wrist, and arm employed in controlling the movements of the foil, but the muscles of the eyes, head, neck, body, and legs are brought into action in watching one's opponent and in continually altering the poise of the body. Thus there is required not only a coordination of impulses issuing to the muscles within a single muscle group, but, to produce harmonious and concerted action in many groups of muscles acting simultaneously and serially, a coordination of a much wider order.

Moreover, the correlation of incoming with outgoing currents is of a more complex nature than is exhibited in simple reflex action. Incoming impulses originate in many sense organs in different parts of the body. Not only

does the fencer watch his opponent, but his movements are guided by the pressure of the foil, and his poise is determined partly by sight, partly by his sensations of movement, and partly by the pressure of his feet on the ground. The sense organs as a whole, in such an action, must be united in correlated action, and, further, must be correlated with the coordinated movements of the body as a whole. The nerve centres controlling actions of this kind must, then, have nervous representations from all the sense organs and all the muscles involved. They must be centres in which the sense organs as a whole are brought into intimate relation with the muscular system as a whole, in such a way as to produce harmonious action of the organism as a whole.

Centre for Intelligent Conduct.

The highest form of nerve centre is seen in the cerebrum, the centre involved in intelligent action. Its work is of a most complex character. The activity of its nervous tissue is, in some unknown way, related to mental activity. The perception of things, the conception of abstract qualities and relations, the performance of voluntary movements, the emotions—all have some counterpart in physical activity in the nervous tissue of the cerebrum. The nature of the connexion that exists between mental states and nerve states is beyond our knowledge, but the fact is familiar.

The function of intelligence in life is to secure unity of purpose and of action. In a previous chapter it has been seen that the essential characteristic of the human mind is its power of conceiving the lasting and permanent welfare of the organism and of adapting the conduct of the organism as a whole to that ideal in the varying circumstances of life. In such conduct past experience is an essential factor in securing unity of purpose and of action.

Intelligent adaptation of means to an end necessitates memory and the power to guide present conduct in the light of memorised experience. Such conduct is well exemplified in the mental aspect of such an act of skill as fencing. In fencing a man has his attention occupied not only with incoming impressions but also with past experiences. His attention is fixed on his opponent. He watches his eyes and movements. He feels the pressure of his foil. These impressions of sight, movement, and pressure are, however, but signs which he has to interpret. They are only the raw material out of which he will, by his past experience, construct an idea of his opponent's strength and weakness and of his plan of attack and line of defence. His intelligence, moreover, goes beyond the present into the future. With the knowledge he has gained of his opponent, together with the knowledge of his own skill, he plans for himself a system of attack and defence suited to the circumstances. Conceiving the future in this way, he lays traps for his opponent. He watches for openings and chances that are already foreseen, and is thus ready to seize on them and turn them to his advantage when the first sign of them is presented to his perception.

Intelligence thus builds up a complex mental structure. It endeavours, out of the impressions from the many sense organs and with the memory of past experiences, to construct an idea of what is and what might be, and to form plans of action by which the former may develop into the latter. Intelligence thus forms correlations and coordinations of various kinds of activities on a plane much wider and more extensive than is seen either in simple reflex action or in purely automatic action. All the senses and organs of movement are involved not only in present action, but also in past conduct and with regard to future

conduct. Intelligence correlates the past with the present and anticipates action in the future. In this way the conduct of the organism is unified over considerable periods of time.

The unifying action of the cerebrum is still further brought home to us when we consider the nature of mental life. The mind is essentially a unity. It is the same mind that perceives the yellow roundness of an orange, wills to seize it, guides the movements in grasping and feeling, and experiences the pleasure of tasting the sweet juice. This oneness of mental life is further exemplified when we distinguish the elements that may exist in any experience. Various kinds of sensations—of sight, of touch, of taste, of movement—with their accompanying pleasurable or painful tone, may all be brought together in one experience of an object, and in the recollection of that experience any one element reproduced may be the means of recalling the rest. Furthermore, all movements are under the control of the will, and intelligence may guide them to their end by means of impressions received from any of the sense organs, or by the sense of movement.

It is clear, then, that in the cerebrum, the centre of intelligent action, every bodily function that has a mental correlative will be represented. Nerve paths from the sense organs will terminate in this centre, and from it will originate paths that end in the executive organs whose actions can be controlled by the will or affected by conscious states. Though so many sets of neurones terminate, or find their origin, in the cerebrum, yet they are bound together into one central organ, for, as we have insisted, the cerebrum's main function is to secure unity of action. The activity of any of the senses can be correlated with the action of any of the muscles, and any one group of muscles can function at will in coordination with any other

group. The cerebrum, therefore, is the supreme head centre for controlling the organism throughout life. It correlates and coordinates in accordance with an intelligent purpose the action of senses and muscles, and through the power of memory and reason secures unity of conduct over long periods of time.

It is seen, then, that the central nervous system consists of a large number of nerve centres which, however, are bound together by connecting strands into one organ. Some of the centres are simple, controlling the functions of limited bodily areas. Others are complex, governing the concerted action of parts widely distant. All act under the supreme centre, the cerebrum, which unifies the conduct of the whole organism with respect to a welfare ideally conceived.

6. Before considering the definite function of the various nerve centres it will be convenient to have some general notion of the build of the central system.

General Structure of the Central Nervous System.

The brain is contained within the skull, and the spinal cord within the vertebral column. In the embryo, that mass of cells which is to develop into the nervous system shows itself as a hollow tube, the fore end of which undergoes considerable development to form the brain.

At an early stage this portion enlarges into a bladder-like formation which divides into three parts, fore, mid, and hind brains. From the anterior portion of the fore brain grows the olfactory nerve, and the optic and auditory nerves develop from the mid and hind brain respectively. The great development of this portion of the neural tube is probably due to the important part the three organs of smell, sight, and hearing play in controlling the actions of the organism as a whole with respect to its environment.

To effect such a purpose these centres must not only contain nervous elements from these three important sense organs, but also representations from every part of the body with which these sense organs have to work in correlation. Hence it comes about that the brain contains nervous

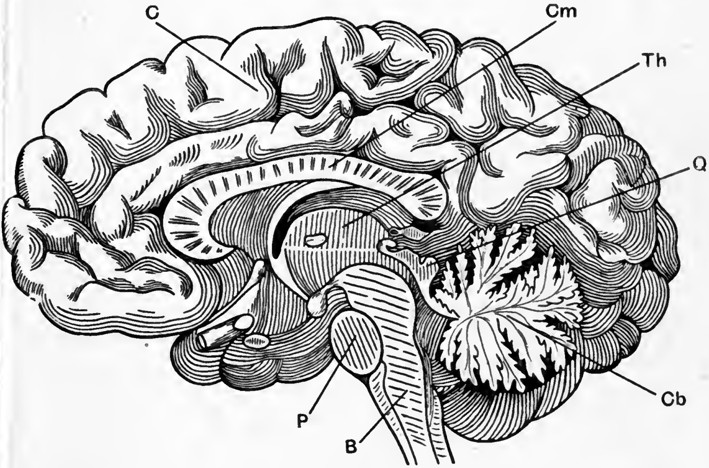

Fig. 3.—MEDIAN SECTION OF THE HUMAN BRAIN. Copied from Wundt: *Principles of Physiological Psychology* (Sonnenschein).

C, Cerebral Hemisphere; *Th*, Thalamus; *Q*, Quadrigeminum; *Cb*, Cerebellum; *Cm*, Band of Commissural Fibres; *P*, Pons; *B*, Bulb.

representations of all parts of the body and governs the conduct of the organism as a whole. The brain, indeed, represents the organism as a single individual.

Of the three segments of the brain the fore and hind undergo the greatest development. Two large lobes, the *cerebral hemispheres*, grow from the sides of the fore brain. These lobes enlarge to such an extent in all

directions, forward, backward, downward, and upward, that finally they entirely overlap the mid brain and even project over the hind brain.

In the hind brain the floor of the hinder portion thickens to form the bulb, while its roof remains entirely undeveloped and is seen as a lozenge-shaped opening. The roof and sides of its fore portion expand, and form the *cerebellum* or little brain which overhangs the hinder portion. The floor of this fore portion thickens to form the *pons* or bridge, so called because it consists largely of strands of fibres joining the right and left lobes of the cerebellum. The fibres of the bulb pass through the pons interlacing with its transverse fibres, and, enlarged by fibres from the pons, they proceed forward into the floor of the mid brain, forming two distinct bands—the *crura cerebri*, or legs of the cerebrum—in the floor of the mid brain. These strands diverge, and each enters the cavity of the cerebral hemisphere of its own side, and, with its fibres radiating fan-like, passes into the substance of the cerebral walls.

The roof of the mid brain grows into four globe-like bodies, the *corpora quadrigemina* or the four twin bodies, while the walls of the fore portion develop into two large masses, the *optic thalami*, which project into the cavity of the fore brain.

We have continually insisted on the fact that the central system is a collection of nerve centres. These centres consist of a collection of cell bodies in a network of interlacing fibrils from the dendritic processes and nerve fibres. The centres are joined together into one compact system by an extensive network of similar grey matter composed of ramifying and interlacing fibrils. Besides this column of grey matter extending throughout the whole central system, bands of white fibres, which pass upwards

and downwards and across, bind the centres together and form the means whereby centre can act with centre, and the whole function in harmonious action.

Structure of Spinal Nerve Centres.

7. The centres in the spinal cord are the simplest in structure, and it would be well to understand clearly the arrangement of the afferent and efferent neurones in these centres before considering the arrangement in the more complex centres of the brain.

The spinal cord is cylindrical in shape, with a small neural canal running through its whole length, a continuation of the larger vesicles of the brain. It is brought into relation with the bodily organs which its centres control by thirty-one pairs of spinal nerves. Each spinal nerve joins the cord by two roots: one, the dorsal or posterior, consists of afferent sensory fibres; the other, the ventral or anterior, of efferent or motor fibres. The two roots remain separate for a short distance, during which the sensory root passes through a ganglion of nerve cells. Beyond this the roots unite into one nerve, which distributes itself over that part of the body whose activity it governs.

The arrangement of the grey and white matter in the cord is fairly regular throughout its own length. The grey matter is situated in the centre of the column and is in the form in cross section of a double crescent joined by a narrow isthmus which encloses the neural canal. Outside this are bands of white fibres passing lengthwise up and down, while one thin strand of fibres, called the *white commissure,* anterior to the neural canal, joins one side with the other.

At the junctions of nerves and cord the cells in the grey matter are more numerous. In the intervals between the junctions the cells are scarcer and the grey matter is largely composed of the interlacing network of branching

dendrites and fibre endings. The grey matter of the cord may, then, be conceived as a number of paired ganglia, each receiving an afferent and giving off an efferent nerve root. Each pair of ganglia is joined by an isthmus of grey

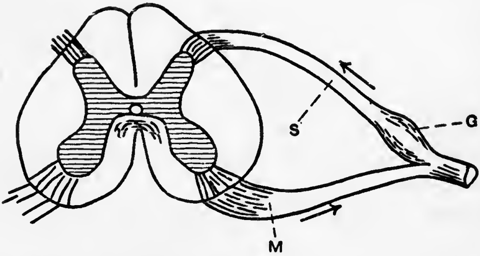

Fig. 4.—SECTION OF SPINAL CORD SHOWING DOUBLE CRESCENT OF GREY MATTER AND SENSORY AND MOTOR NERVE ROOTS WITH SPINAL GANGLION.

fibrillar network, while the pairs are joined longitudinally by the grey column and the white bands of fibres lying on the outside of the cord.

Each ganglion is a nerve centre, and its function is to bring various sets of neurones into definite connexion, so that stimuli reaching the centre either from the periphery of the body or from some other part of the central system can induce definitely coordinated outgoing impulses. The connexions it makes are, therefore, of two distinct kinds. First, afferent neurones connected with some sensory area of the body are brought directly and immediately into relation with efferent neurones proceeding to muscles or other bodily organs. Second, the efferent neurones are brought into connexion with fibres from the higher centres in the brain. In the front horns of the crescent are numerous and large cell bodies. Each gives off a fibre, which passes into the efferent root, and so to the glands or

muscles, the action of which the centre governs. The dendrites of these cells ramify largely in the grey matter, and, as will be seen, are brought into connexion with the terminal fibrils of the nerve fibres coming to the centre.

The fibres of the sensory root follow a different course. Their cell bodies make up the ganglion of the sensory root. Each of these cell bodies gives rise to a fibre that soon divides into two portions. One passes to the sensory region in the periphery of the body; the other enters the cord and divides at once into an ascending and a descending part. Each of these gives off lateral branches which terminate in the grey matter in branched endings. The main stems, after travelling some distance, finally end in a similar way in the grey matter.

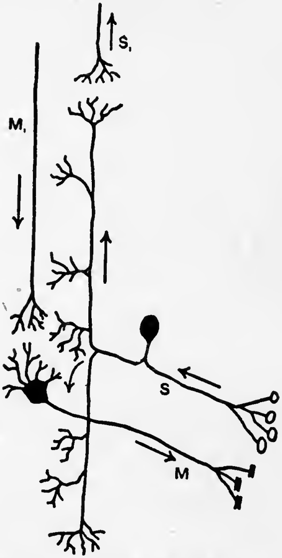

Fig. 5.—Diagram showing Arrangement of Neurones in Spinal Centre.

S, Sensory Neurone; *S,,* Conduction Path to Higher Centres; *M*, Motor Neurone; *M,,* Conduction Path from Higher Centres.

By means of these several branchings the sensory fibres are brought directly into relation with many sets of motor neurones—(1) with those of the same segment and on the same side, (2) with those of the same segment, but on the opposite side, (3) with those of segments situated above and below. Stimuli, therefore, which enter the cord from a sensory area can thus directly induce discharges to organs

controlled from the same segment or from segments higher up or lower down. The spinal centres, then, do not act in isolation. Many can be thrown into action by the same sensory stimulus; the result is movement in several bodily areas. It is clear that though the afferent and efferent fibres of each segment are correlated, yet, by the distribution of the sensory fibres, the cord can act as a whole. It is not a mere collection of independent centres, but a united system of centres.

Nerve Tracks connecting Spinal and Brain Centres.

8. Each centre, besides bringing its efferent neurones into connexion with its own afferent neurones, brings them into connexion with fibres coming from the higher centres in the brain. Bands of fibres descend from the cerebrum, the mid brain, and the cerebellum, and give off to each ganglion fibres whose branched endings make connexion with the dendritic processes of the motor neurones that leave the cord.

(*a*) Motor Tracks.

The most distinct descending path is from the cerebrum. Two large bands of fibres pass from the two cerebral hemispheres, through the crura cerebri and the pons to the base of the bulb. Here the majority of the fibres cross from side to side. The crossed fibres then descend in two distinct paths, the *pyramidal tracts*, down the whole length of the cord, giving off fibres to the efferent motor neurones in each segment of the cord. The uncrossed fibres also pass downward and cross in various parts of the cord, forming the transverse white commissure previously mentioned. Hence the motor areas of the right hemisphere control the muscles of the left side of the body, and those of the left hemisphere the muscles of the right side.

Besides this direct path from the cerebrum to the various spinal centres there are other paths from the brain centres

in the cerebellum and mid brain, so that all the main brain centres, which govern the conduct of the organism as a whole, make connexions with the spinal centres, and stimuli from these higher centres can thus induce co-ordinated discharges from the spinal centres to the muscles and other organs controlled directly from the cord.

(b) Sensory Tracks.

It has been seen how sensory fibres entering the cord distribute themselves upward and downward and so make connexion with several spinal centres. It now remains to be seen how sensory stimuli entering the cord by these fibres reach the higher centres in the brain. Ascending paths to the brain consist of chains of neurones forming many links before they finally terminate in the sensory areas of the cerebrum. This chain structure seems to be specially suited to securing the divergent distribution of sensory stimuli in many directions. Each junction in the series presents an opportunity for the ascending stimulus to induce excitations in neurones converging on, or rather diverging from, the junction. In the bulb and mid brain in particular are nuclei of cell bodies whose special function seems to be that of distribution. On the one hand, these cell bodies are in connexion with the endings of the sensory fibres entering the cord; on the other, with fibres that pass to the cerebellum and the centres of the mid brain, from which further continuations proceed to the cerebrum. Besides this interrupted afferent path there are two bands of fibres that bring the sensory fibres of the cord into direct connexon with the cerebellum.

Thus, on the sensory side afferent impulses entering the cord may set into action (1) the simple centres of the cord, (2) the higher centres in the bulb, mid brain, cerebellum, and cerebrum, and this because of the interrupted structure

of a chain of neurones forming many links and thus giving many opportunities for divergent distribution.

Centres for Cranial Nerves.

9. The bulb and pons, besides being the highway through which ascending and descending fibres pass between the cord and the centres above the bulb, and besides possessing nuclei of nerve cells which act as centres for the distribution of afferent stimuli to the different higher centres, contain a number of centres from which originate the majority of the cranial nerves.

These in their general plan follow the structure already described with respect to the spinal centres. They bring afferent and efferent neurones from the bodily organs directly into connexion with each other and with fibres passing along the main sensory and motor tracts already mentioned, and thus connect them with the higher centres above.

The Centres of the Brain.

10. The cerebellum, the mid brain, and the cerebrum are the most important centres of a higher order by which correlations and coordinations of a more complex kind are carried out.

The Cerebellum and its Connexions.

The cerebellum, as has been seen, is the enlargement of the roof and sides of the fore part of the hind brain, and consists of three lobes—a central and two lateral. The arrangement of white and grey matter in this centre differs from that in all other parts of the nervous system except the cerebrum. The grey matter, consisting of cell bodies and interlacing network of fibrils, is situated on the outside, and is called the cortex. Fibres in three masses pass from the cortex to the centres above and below. First, as has been already described, afferent fibres pass from the cord in two bands, some directly, others by way of the distributing centres in the bulb. In the second place, motor

fibres pass from the cerebellum to nuclei in the pons, by which they make connexions with the motor tracts passing from the cerebrum to the cord. Lastly, fibres pass forward to the centres in the mid brain and to the cerebrum. The cerebellum is, therefore, a kind of shunt from the main sensory and motor tracts which connect the cerebrum and the cord, and its function is that of acting as a kind of automatic regulator of complex actions of the body as a whole.

Function of the Cerebellum.

In actions such as walking, dancing, and lifting weights, which involve movements of the body as a whole, the balance of the body is continually being disturbed and many muscles of the trunk and limbs are as continually being exercised to maintain a correct attitude. The maintenance of equilibrium, even for a moment, is a very complex muscular act, while in a prolonged movement it is only by the harmonious concerted action of the whole muscular framework that the balance is continuously maintained through constantly changing attitudes. Usually the balance of the body is kept by entirely automatic impulses to the muscles. Only under special difficulties, as in walking on a tight rope, is the automatic control assisted by voluntary effort. The automatic nature of the maintenance of equilibrium is well exemplified when a man suddenly loses his balance. If a man suddenly stumbles forward, his arms are shot out and his head and body are jerked back with a suddenness that is little consonant with intelligent action. The attempt to recover the balance is thus on the same level of automatism as is starting back from a blow or blinking the eyes to a flash of light.

Since the maintenance of equilibrium is automatic, the sensory impressions that are primarily instrumental in

stimulating the muscles to action are largely those that do not figure in full conscious life. As a matter of fact they are those that, as a rule, are in the background of consciousness and only come into the foreground of mental life when specially attended to. The best known of the impressions that stimulate the muscular frame to preserve its balance are impressions of sight from surrounding objects, especially from the floor and ground and from vertical walls, impressions of the movements of the body and limbs and of the pressure of the body, and impressions of the contact of the soles of the feet with the ground. Besides these there are others less known. In each internal ear are three structures, called the semi-circular canals, placed at right angles to each other and filled with liquid. Any change of position of the body, to right or left, forward or backward, causes some movement of the liquid in one or other of these canals, and the canals being well supplied with sensory nerves, impressions that are largely used in the automatic maintenance of balance are conveyed to the brain.

The continuous and automatic maintenance of equilibrium of the body in its constantly changing attitudes is, it is generally thought, the work of the cerebellum. The connexion of this centre with the principal sensory and motor tracts from and to the cord is thus explained. It has to receive impressions from the feet, from all the muscles, from the eyes, and from the ears, and to send impulses to the muscles of the whole frame. It must thus stand in almost as central and dominant a position with respect to the body as the cerebrum itself. On the other hand, since equilibrium has to be maintained in voluntary movements, its connexion with the cerebrum must be intimate and close. Its position as a kind of shunt between the cerebrum and the cord is thus clear, since the

voluntary control of the cerebrum over the muscles of the body must be in harmony with the automatic preservation of equilibrium by the cerebellum.

Connexions and Function of the Centres of the Mid Brain.

The centres in the mid brain act as intermediary stations for both sensory and motor paths. They take up fibres from all the centres below them, and pass fibres forward to the cerebral hemispheres. Their function is an important one in the control of conduct, involving activities of several sense organs and many groups of muscles.

In a voluntary action much of the coordination and correlation of the elements out of which the action is constructed is of an automatic character. Whatever part of the control of the action is performed by intelligence has undoubtedly its seat in the centres of the cerebral hemispheres. But these centres function over those in the mid brain and the spinal cord. They do not act directly on the muscles. It is only through the lower centres that those in the cerebral hemispheres can act on the organs of movement. It is natural, therefore, to expect the centres in the cerebral hemispheres to make use of whatever organisation for movement exists in the lower centres. Hence, some part of automatic coordination and correlation, especially that which is simple and confined to activities of a limited bodily area, is the work of the spinal centres. Some, of a wider and more complex character, is carried out by the centres in the mid brain. Probably, also, some part of the automatic element is due to the activity of the centres in the cerebrum. Thus, in any piece of intelligent conduct, control is not centred solely in one part of the central nervous system, but is distributed throughout the centres in an ascending order of complexity.

The Centres in the Cerebrum.

The cerebral hemispheres, with the enlargements in the floor of the fore-brain, are the final terminal stations of the sensory and motor paths of conduction. The grey matter, called the cortex, and consisting of cell bodies and a network of infinitely interlacing and branching fibrils, lies on the outside. The white matter is in the interior and consists of bands of nerve fibres that come from and pass to the lower centres. Besides these bands of fibres there are numerous connecting or commissural strands that bring the various parts of the cortex into intimate relation with each other. So numerous and intricate are these connecting bands that it is evident that their function is so to bring all parts of the cerebral cortex into relation that the cerebrum can act as a whole and not merely as a number of more or less independent centres.

Through the cerebrum the behaviour of the organism is controlled in an intelligent and voluntary manner. Hence, every sensory and motor activity that is concerned in voluntary conduct must be represented in the cortex of the hemispheres. This representation of bodily activities is very markedly shown in the division of the cortex into areas corresponding to the different bodily activities. The main division is into a sensory and a motor area; the former being chiefly instrumental in the life of sensation, the latter in the control of movement. Each of these areas is further divided: the sensory into areas of vision, touch, taste, sound, and the other sensory activities, the motor into areas corresponding to the different movements of the body.

The cortex of the cerebral hemispheres may thus be regarded, not as one centre, but as a collection of centres representing the different bodily activities. And each of these cortical centres is a true centre, for it is not so much

organs as activities that are represented. Each area is, in the full sense of the term, a centre for correlating and co-ordinating activities into a definite action. The centre of vision, for example, not only contains representations from the organ of sight, but from all the other organs, sensory

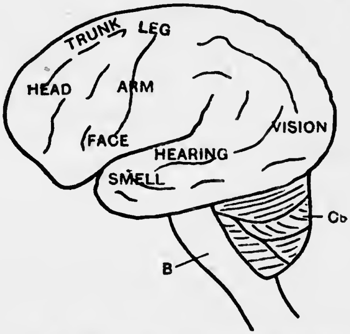

Fig. 6.—Diagram of the Left Hemisphere of the Brain Showing Motor and Sensory Centres.
Cb = Cerebellum; *B* = Bulb.

and motor, with which it has to work in correlation. Though mainly containing nervous elements concerned with vision, fibres radiate from it to the other sensory areas and to the motor areas, so that visual activity can be brought into correlation with other forms of sensory and motor activity.

The motor areas still further exemplify the fact that the centres represent activities and not organs. Each area does not so much represent a muscle group as the movements the group can make. Hence the many skilled movements of the arm have much larger representation in the cerebral cortex than the less numerous movements of the leg, though the size of the former muscles is considerably less than that of the latter. Hence, too, each area

for the control of any muscle-group is divisible into smaller areas corresponding with the different movements of that group—flexion, extension, or whatever other movements are made.

Each area is, then, a true centre for the correlating and coordinating of elements of activity into a whole. Although each cortical area contains chiefly the representations of some one element of sensory or motor activity, yet it contains also representations of all others with which it can act in correlation. Fibres radiate from it to all the other sensory and motor centres. The various centres are thus brought into united action by means of the immense number of fibres that pass from centre to centre. The cerebrum, therefore, although a collection of centres, can act as a whole and this unity is reflected in the unity of mental life and of voluntary action.

Summary.

11. Briefly revising the main outline of this complex structure, the following points stand out as important.

The cerebro-spinal system consists of a vast number of neurones placed side by side or in ascending series and so organised as to form a number of centres where afferent stimuli can induce discharges in efferent neurones.

The centres in the spinal cord are simple centres that bring the afferent and efferent neurones from the bodily organs directly into relation, but with the afferent neurones so distributed that the spinal centres can, to a large extent, act in concert with each other.

The centres in the brain are more complex. By means of distribution centres and bands of nerve fibres they are brought indirectly, through the medium of the sub-centres in the cord, into connexion with all the organs of the body, so that correlations and coordinations of a more complex character can be established. Lastly, above all

stands the supreme centre, the cerebrum, containing representations of all the sensory and motor bodily activities, acting on the regions of sense and movement not directly, but only through the complex centres in the mid brain and the simple centres in the spinal cord.

There is thus a series of centres of ascending complexity beginning with the spinal centres and ending with the cerebrum, each higher one acting through those below. By this means correlations of incoming stimuli with outgoing impulses of various degrees of complexity can be established and coordination of a simple or high order becomes possible.

CHAPTER V.

THE EDUCATION OF THE NERVOUS SYSTEM.

The Development of Nerve Cells: in Size.

1. Like every other organ in the body the nervous system is imperfect at birth. Its size and weight are but a fraction of what they will become, and its functioning power is largely undeveloped. Though the nervous system increases rapidly both in size and in weight, this increase is not due to the addition of any new nerve elements, for after birth no new cells are formed. The increase is solely the result of the development of the nerve cells present when the child is born.

Many of these cells, at birth, are in quite a rudimentary state. They are small in size, mere granules in fact, and possess neither dendrites nor fibres, and hence are incapable of performing any nervous function. Such cells are only the seed out of which, under proper conditions, will be developed to the full, by the growth of nerve fibres and dendritic processes, cells capable of performing their functions. The increase in size and weight, then, though in part due to the enlargement of the cell body, is in a large measure the result of the development of nerve processes and is, therefore, a sign of an advancing functional power.

in Functional Power.

Though increase in size and weight is some indication of developing power, it does not give the exact measure of it. For example, the brain attains its greatest weight at the early age of fifteen, yet it is not until long after that year that it acquires its full functioning power. Development in functioning power, indeed, continues rapidly up to the age of twenty-five, and less noticeably up to the age of forty; after that age it is doubtful whether any further advance takes place. It is the growth of processes and the making of neurone connexions that bring an advance in the control over the activities of the organism. Where processes do not exist or are rudimentary in character, control is impossible. Where connexions are loose and embryonic, activities will be awkwardly and clumsily carried on. Only where the connexions have become definite, fixed, and intimate will activities proceed easily, quickly, and without hesitation.

The Development of Nerve Centres.

2. Necessarily, many of the centres at birth are almost perfectly organised, or even vegetative life in such a complex organism as the human child would be impossible. The child can breathe, suck, digest his food, and perform similar actions essential to his organic welfare. Such actions, however, involve more or less complex correlations and coordinations at the centres that control them. Incoming stimuli must evoke definite and orderly series of outgoing impulses in order to produce appropriate activity in muscle or gland. Certain neurone connexions of a definitely organised character must, then, be inherited by the child, and must be in full going order at birth. In other words, definite and fixed conduction paths for nervous discharge between sensory areas and muscles exist at birth, whereby the organism can respond by appropriate

Hereditary Nervous Organisation.

movement to certain particular external and internal conditions.

Acquired Nervous Organisation.

On the other hand, many centres are, at birth, in a state of rudimentary organisation, and only gradually attain during the years of growth the full measure of their functional power. The various centres, however, do not all begin to develop their organisation immediately after birth. Some begin to acquire the power of controlling activities early in life; others lie dormant for years. Nor is the rate of development equal in all cases. Some centres only attain their full power slowly and gradually through easy stages; others develop rapidly a large measure of their capacity and in a short time change markedly the character of the child's conduct.

Each centre, then, has its own appointed time for its development to begin. When this time arrives the cells of the centre begin to grow in size, to push out processes and to make connexions with other neurones. For some time development progresses rapidly, the line of growth being determined by hereditary tendencies and by the nature of the child's occupations and pursuits. The period of growth is not, however, indefinitely prolonged. In some cases it may extend over many years, in others only over a few months. Sooner or later, however, there comes a time when the power of spontaneous growth gradually declines and finally fades away.

Correlative Development of Mental Life.

The development of functional power in the various centres has its counterpart in the mental life of the child. From infancy to manhood there is seen the gradual awakening in succession of spontaneous instinctive impulses to engage in different kinds of activity. At one period the child is impelled by its nature to sensory,

at another to practical, and later to intellectual activity. These signs of advancing mental life are the mental expression of the growing physical life of the centres for these activities. As each centre in turn awakens to growing life, and its cells begin to grow in size and to push out processes to make connexions, new lines of sensory, practical, and intellectual impulse show themselves. For example, the appearance of the impulse of curiosity, which is so spontaneous and intense, and governs for so many years the life of the child, is but an indication that the centres of sight, hearing, taste, and touch are filled with growing life. Similarly, when the child is impelled to handle objects, to tear things to pieces, to endeavour to talk or to walk, the centres for these activities are in active physical development.

Time for Training the Centres.

Since each centre has its own appointed time for beginning its development it will be useless to attempt the education of any centre until the first signs of awakening life show themselves. An over-anxious mother may begin too early to teach her offspring to walk and to talk. When the child begins to show that he wants to learn to talk and to walk is the time to take measures to educate the centres of these activities to an effective and valuable control. No earlier efforts will be of any avail. Much time may be wasted and much harm done by premature attempts to induce children to learn to do things before their nervous organisation is ready. Only too frequently in school are children forced to try to exercise their fingers in delicate and intricate movements which the immature state of the centres for these actions will only permit them to perform in an awkward and clumsy manner.

Just as training can be begun too early, so it can be delayed until too late. The power of spontaneous development

has its spring and summer, but winter comes at last, when the power, if not dead, is at a low ebb. To delay training beyond the period of growth is fatal to the acquirement of skill. Training will have its greatest effect in producing an organisation for the skilful and effective control of valuable practical activities when the centres are developing rapidly and the cells are spontaneously pushing out processes and making connexions with the fibrils of other cells.

During this time, too, there will appear the impulsive longing to engage in those activities the centres for which are in their period of rapid growth, and such instinctive desire should be seized and turned to good account. Education should follow the line of least resistance, and make use of the natural forces urging the child to active life. Vague longing should by experience and guidance become particularised into concrete interests. The general impulse to do something should develop into clear and definite purposes of value. Should this period of spontaneous growth and activity pass without the centres being moulded by exercise to an organisation of value, then the power of spontaneous growth and impulsive desire will wane and die. Future efforts will then meet with no innate internal force to make learning a pleasure and to aid the acquirement of skill, and no permanent interests or fixed habits will have been formed. In the life of a youth, for example, the period from twelve to twenty-five years of age is a time when the centres for the control of such larger bodily movements as are employed in running, walking, and wrestling are rapidly developing. This growing life is exhibited in the impulse to engage in sports and games that dominates this period of life. Football, cricket, swimming, and other violent exercises are desired with intense avidity. If, however, this period pass with few or

no opportunities for playing games, then the spontaneous longing for outdoor exercise will fade, and the grown man will be all the poorer in health, in interests, and in power.

Order of Development of Motor Centres.

Speaking generally, the centres for the control of the larger and less complex movements of the body and limbs develop first; those for the finer, more delicate, and intricate movements develop later. The child kicks his legs, flings his arms about, and wriggles his body before he acquires the power of grasping an object with his fingers and of guiding an instrument with precision. During adolescence, however, when the muscular and bony framework is rapidly growing, there is a tendency for the muscles to outgrow the power of control. It is a fact of common observation that a youth at this age is markedly awkward and clumsy in his general movements. The centres for general bodily movement are called on to adapt themselves to rapidly growing executive machinery, and naturally their action is far from perfect. What is needed, then, at this period of life, is some system of exercises by which these centres will be aided to attain a more perfect control.

The Influence of the Play and Imitative Instincts on the Development of the Centres.

3. During the early development of a centre of motor control the movements that are spontaneously made are of an indefinite kind and are characterised by no purposive objective. Such are the kicking and flinging movements of the young child, which are evidently the result of the excitation of centres in which connexions, though existing, are unorganised for the control of definite purposive actions. Such an organisation has to be acquired, and the process of learning must consist in the making of such connexions at the centres that definite and fixed conduction paths are formed by which particular afferent stimuli will evoke definitely coordinated efferent impulses.

The organisation for the control of definite purposive movement is of gradual growth. The development of its early stages is due to the prompting of the natural impulse that is one aspect of the growing life of the centre. The active, practical play instincts of the child are his first educators, and education can but follow in their footsteps and by guidance turn instincts into interests of value, and the machinery of movement into an instrument for skilled work. The first training, however, is by the constant and varied exercise that the child, boy, and youth ceaselessly indulges in during the period of growth. In the early years he gains his first training in motor organisation by flinging his arms about and kicking his legs; later it is by crawling, balancing, walking, climbing, jumping, grasping at objects, pulling them to pieces and rolling them about; later still it is by making things with his fingers or with tools and trying to imitate the doings of his elders; then by running, catching, throwing and wrestling games. These spontaneous forms of activity are his natural modes of acquiring skill; instinctive longing and desire his stimulus; experience and imitation his guides.

The ceaseless and varied exercise of every new power as it appears results in the indefinite and vague movements becoming definite purposive actions. The main forces at work developing the former movements into the latter are experience and imitation. The constant grasping, handling, throwing, rolling, pulling to pieces that go on with every object within reach of the young child lead to a body of experience being gained with respect to the objects so experimented on. Each object is acquiring a meaning, indeed many meanings; the meanings being the stored-up experiences of grasping and handling and of the endeavours to get this or that control over the object. Out of the many actions performed, some are chosen for repetition,

others for inhibition. The sugar is grasped and hurried to the mouth; the hot tea-pot is carefully avoided. Definite modes of response by experience take the place of vague indiscriminate action. With growing knowledge of actions and of their consequences the child can foresee the results of his movements, and the control over his experimenting becomes more intelligent and deliberate and hence more effective.

Imitation of others, too, is a great factor in the development from indeterminate to definite motor responses. The child spontaneously and unconsciously copies actions he sees just as he instinctively exercises his growing powers, and in this way his motor development proceeds more quickly and easily along the lines that tradition and custom mark out as being the most useful and valuable.

The Formation of Habit.

4. The learning of all new forms of activity is marked by the need of attending to the details of correlation and coordination. The early trials are almost always random efforts made on the chance of their being successful, or crude attempts to imitate the actions of others. Naturally, awkwardness and clumsiness mar their success. Throughout the action intelligence is watching intently each detail of movement and its results, and continually the will is exerted to intensify, inhibit, or otherwise modify this or that part of the action until some measure of success is attained. Progress is only made by repeated trials through failure to success. Each repetition removes some awkward or redundant movement, until there comes a time when the action proceeds smoothly, quickly, and confidently.

Action of Intelligence and Will.

What, however, is of greater importance in the development of motor control is that repetition gradually removes the necessity for attention being paid to the details of

coordination and correlation. The intelligence, when skill is acquired, needs simply to conceive the end to be attained. The will then issues the command to start the movement, and, except for the most general of guidance and control, the action proceeds in an automatic manner. It is evident that repetition combined with intelligent control has resulted in the formation and fixing of definite conduction paths of motor discharge. The intelligence and the will have in some way determined the lines of motor discharge and repetition has fixed them as a permanent nervous organisation. An organisation of neurone connexions has thus been formed in the various centres, by which certain afferent stimuli will evoke readily and quickly definite and harmoniously coordinated outgoing impulses without the interference of the will or the definite guidance of intelligence. Each passage of a wave of nervous excitation must leave behind it traces in a permanent modification of nerve substance and of closer and more intimate nerve connexions, by which the resistance to nervous conduction along that path is lessened for the future. When a similar excitation occurs again it finds prepared a more or less organised and fixed path of least resistance, and so the wave spreads through the system from sensory area to muscles or glands along definite lines marked out for it as the result of previous action. Continued repetition strengthens such paths and leads to more automatic discharge of efferent impulses in response to afferent stimuli.

Influence of Repetition.

The lapse of time, however, without any repetition of a particular form of excitation, weakens the conduction path for that form of excitation. Living tissue is constantly undergoing change, and the connexions between the neurones become, so to speak looser and weaker as time passes without that

Influence of Lapse of Time.

conduction path being used. Want of practice deteriorates the nervous organisation acquired by practice.

Intensive Study.

The bearing of all this on the learning of a new form of activity is obvious. Frequent practice, with short intervals of time between each occasion, is essential to the formation of an efficient nervous organisation for the performance of skilled movements. Long periods of time without practice only give an opportunity for the organisation acquired during practice to become weak and loose. Greater ease and quickness of movement and more advanced skill, for example, can be acquired by four lessons a week for a year than by one lesson a week for four years, though the total time spent in learning is the same in each case. On the former plan the skill acquired during one lesson has not time to deteriorate to any extent before the next exercise strengthens and advances it. On the latter much time is wasted in renewing and reviving the skill lost in the long intervals between successive lessons. The pupils are, on this latter plan, kept continually in the lower stages of the art, and interest is consequently lost. They never attain that degree of skill which will lead them to find a high and lasting pleasure in the work they do and induce them to undertake work of difficulty and value.

Intensive practice is, then, the only high road to the acquirement of skill of a high value, and it is the most economical of school time. Once, however, an organisation for the control of certain kinds of movement has been acquired and fixed, a diminishing amount of practice will maintain in its perfection the skill acquired. It is in the early stages that intensive practice is of the highest value. Later, the frequency of the lessons can be diminished. Hence, in teaching such practical activities as speaking a foreign tongue, reading, writing, drawing, handicraft,

needlework, and practical cookery, lessons during the first year of learning should be frequent, so that an initial foundation of skill may be laid. Practice should take place if possible every day, certainly not less than three times each week. After the first year the number of lessons may be reduced, and the reduction can go still further as skill advances year by year. It is, therefore, not a wise distribution of time for children to be learning many practical activities at once. It is more economical, and advance is, in the long run, more rapid, if one or two kinds be practised intensively each year of school life, so that in each form of activity some reasonably high degree of skill can be reached. After one year of intensive practice a much less amount of exercise will maintain the skill without deterioration.

Precautions against Mistakes.

It is important, however, in learning a practical occupation that wrong modes of performing the work be not indulged in. As has been seen, the first nerve path carved out by an excitation leaves its traces, so that the next occurrence of that form of stimulus finds a path predisposed for its conduction which only the lapse of time can obliterate. Voluntary effort and persistent repetition can, of course, form an alternative path of greater conductivity, but so long as both paths persist there will always be a liability to error.

It is very desirable, then, to take every precaution to avoid wrong modes of doing things from the first moment of learning. It is in the early exercises that bad habits may become fixed and require endless trouble to eradicate. Moreover, bad methods of work only too frequently taint the whole future practice and prevent progress to a high degree of skill. In the early training, then, the proper attitudes and movements should be carefully shown and practised one by one under efficient supervision.

The careful teaching and practice of the details of a movement have another object besides the one discussed above. Advance from simple to complex forms of activity is made only by the elementary forms becoming automatic. The elementary movements out of which a complex act of skill is constructed should then be taught and practised first. If the complex action be attempted without such preparatory practice it is only too likely that imperfect and wrong forms of movement will creep into the action, and much time and trouble will be needed before they are finally got rid of.

Preparatory Practice in the Elements of Action.

In learning an activity of any complexity the pupils should have preparatory teaching and practice in its elements. In the teaching of reading, for instance, examples of distinct enunciation and correct pronunciation should be carefully put before the pupils. The points of special difficulty should be emphasised, and if necessary the action of the vocal organs demonstrated. Collective and individual practice should then follow during which the teacher should be on the alert for wrong sounds and indistinct utterance. Careful demonstration, followed by frequent practice of good modes of speech and constant correction of wrong modes at all times, will, in the long run, result in distinct and correct speaking becoming habitual. Similarly in writing, drawing, painting, handicraft, walking, running, and jumping, the correct attitude in sitting, standing, or moving, and the best methods of using the different tools should be demonstrated and practised.

In view of the importance of careful demonstration and intensive practice, it is wise before each lesson to devote some ten minutes or so to some form of drill by which the execution of some one particular movement can be perfected. The action chosen for practice should, of course, be one that would receive constant application in the lesson to

follow. In such drill—it may be in the writing of an 's,' the drawing of an ellipse or spiral, the enunciation of a final 'ng,' the correct mode of controlling the breath in singing and running, the lunges, parries, and attitudes of fencing—the movement should be carefully examined by the pupils and intensively practised by them until some degree of proficiency is attained.

Such drill, organised in character, advancing in difficulty, and carried out methodically and thoroughly through the years of school life with respect to each form of practical activity, will create so effective and permanent an organisation for the control of those kinds of movements that their performance will become almost instinctive, and advance to higher forms of skill and to more permanent and valuable interests will be possible. Such thorough and methodical drill is recognised as an essential preliminary in the training for an artistic career in music, painting, or sculpture. It is only after years of practice at scales and exercises that the aspirant to success obtains sufficient control over his fingers to be able to devote his whole mind to the emotional effects he wishes to arouse. Although so great a skill is not possible in the practical activities of school life, yet the same principles—of prevention of mistakes, and of continuous and graded practice in the elements of skill—should underlie the teaching of these, if anything but merely rudimentary and childish forms of skill are to be attained by the pupils.

Advance from Simple to Complex Forms of Activity.

By the practice of certain forms of activity the nervous system becomes adapted to the easy, quick, confident, and automatic control of movements. Intelligence is thus left free to bring about correlations and coordinations of a broader and more complex character, which are only possible when those of a lower order have, through

repetition, been made automatic. Consciousness is not concerned with the mechanism of movement, but only with the necessity for it and with the result attained by it. As long as the nervous and muscular machinery works smoothly and successfully, intelligence and will are directed to the wider and more important aspect of the progressive realisation of purpose. Progress from simple to complex forms of activity, therefore, is made on a continually broadening basis of automatism or habit. Practice of simple elementary movements is the necessary preparation for the intelligent synthesis of those movements into complex actions, which in turn become automatic by repetition and give a basis for further construction.

The essence of skilled practical activity, however, is the constant intelligent adaptation of movement to continually changing conditions. In actions like walking, swimming, and cycling, and, to some extent, knitting and sewing, where the conditions remain fairly constant, this is not so. These, however, are only activities of a low order of skill. In these cases there is only the monotonous repetition of one kind of movement, and a nervous organisation can soon be formed that can, within certain limits, act apart from intelligence and will. In such pursuits as carving, fencing, or playing games, constant attention is required on the material or on one's opponents to observe the progressive change of the conditions. No fencer, sculptor, or painter, no matter how skilled in his art, can for one moment relax his attention. The fencer, for example, is continually on the alert, watching every movement of his opponent's eye and foil, keenly on the look out for any spot not thoroughly guarded, and thinking out some feint by which he can disclose his opponent's mode of attack or the weakness of his defence.

The whole action, though highly adaptive and requiring

keen attention and acute intelligence, is constructed on a basis of automatic movements. The strokes of an artist's pencil, the feints, guards, and lunges of a fencer are perfectly mechanical in character. The lunge of an opponent calls out without deliberate thought the appropriate parry and *riposte.* The idea of a curve is followed without mental effort by the movements of the hand and arm in making it. The perception or idea has acted as a kind of trigger to let loose the mechanism of movement, which then goes on smoothly and easily with only the most general mental control.

Such a basis of automatic action is absolutely essential in all advanced forms of skill. It is only when the artist has by practice perfected his hand to the drawing of many kinds of forms that his mind is free to combine these in the production of a work of art. In all practical arts attention must be on the end and not on the process of attaining it. Only when such a stage is reached can results of really artistic merit be produced, and such a stage is only arrived at by thorough and systematic practice in the elements of skill.

The intelligence and the will, however, have their physical aspect in the activity of the centres of the cerebrum, and are, therefore, subject to the law of habit. The direction of conduct by the will follows certain general lines which repeated practice has fixed as permanent tendencies. At first the will is exercised in each piece of conduct in securing honesty of purpose, persevering and persistent effort, critical care and caution, and neatness and precision of execution. Continual efforts to secure these qualities in conduct, however, leave their traces on the nervous system, especially on the higher centres which direct conduct as a whole. Such qualities then become habitually operative in directing all conduct. Thus, conduct in its general direction

by the will, as well as in the elements from which it is constructed, is under the influence of habit. The executive habits may be regarded as the servants of mind, the machinery by which it works out its ends; but the mind itself is not entirely free, for in all its operations it is guided by habitual tendencies of a general character suited to dealing with situations varying considerably in detail but similar in general characteristics.

The Perceptual Element in Practical Activity.

5. In practical activity, it has been seen, a series of movements is guided to its end by a series of perceptions. Prominent among the perceptions usually relied on in skilled occupations are those of vision and touch. Hearing, of course, is an important sense in such actions as reciting, singing, and playing a musical instrument. Less obvious, but of at least equal importance in guiding movement, are muscular impressions produced by the movements themselves.

Muscular Impressions.

The muscles are not only executive instruments for carrying out movements, but also sensory areas. Afferent nerves pass from all the muscles to the central nervous system, and convey sensory stimuli by which the intensity and nature of each movement can be 'sensed.' Each movement is thus followed by a series of return stimuli by which we become aware of the nature of the movement made.

Much of our experience of objects—their size and weight, the resistance they offer to force, and the pressure they exert—is thus gained in terms of movement. Such experience constitutes a most valuable part of our knowledge of objects from a practical point of view, because it is knowledge which is indispensable when action with these objects is contemplated. For example, it is little use for a bowler to possess the information that he has to pitch a

cricket-ball twenty yards and break it to the right or left, or simply to watch another man perform the feat. He must not merely have some knowledge about bowling, but must know what bowling means in terms of muscular energy and muscular movement; and this he can only experience by bowling many balls, and so through many trials and by continual effort attaining success. Again, in drawing it is more important from a practical point of view to judge a curvature in terms of the sweep of the arm or turn of the hand and wrist in producing it than to interpret it solely by the eye. Motor experience is, then, indispensable to successful action. It is that experience which is most intimately and closely associated with the movement itself, for it is the direct outcome of that movement, and becomes essential to its proper guidance.

Visual Impressions.

Visual experience is necessarily of great importance too, and this to some extent can be acquired at second hand. Watching an artist draw, and a bowler bowl, or even reading or hearing a description of how they do their work, provides some data with respect not only to the end to be attained, but also to the process of attaining it. It is on experience of this kind that imitation has to rely. Example and precept are important educators and appeal to sight and understanding. By these means the nature of the work to be done, the mode of doing it, and the mistakes to be avoided can best be demonstrated. They cannot, however, be the only means employed in teaching practical activities. Personal experience of a practical motor kind is essential when practical skill is the aim of teaching. Not only is the motor experience which is indispensable to the successful guidance of movement gained in that way, but the impressions of sight and touch are more thoroughly and intimately correlated with those of movement and with the movements

themselves than can be the case when precept and example only are relied on.

Tendency of Teaching to rely on Visual Impressions.

In a superficial analysis of our experience muscular impressions are apt to be overlooked. They do not stand out so prominently as our impressions of sight, sound, or touch, and hence there is a tendency to ignore them unless we begin with set purpose to seek for them. In drawing an ellipse on a blackboard our eyes are so intent on the shape being produced that the impressions of touch and of muscular exertion in holding the chalk, in overcoming the resistance of the surface, and in moving the arm fall into an undiscriminated background of consciousness. By closing our eyes and then endeavouring to draw the ellipse our attention is forced on to the impressions previously overlooked, and we are driven to guide our movements solely by the senses of touch and movement. Even impressions of touch can be eliminated by making the movements of drawing the ellipse in the air instead of on the surface of the board. We then become distinctly aware of muscular impressions that indicate, without doubt, the kind of figure which is being made.

So prominent usually is our visual experience and so clearly has it been analysed, so definitely organised, and so precisely expressed in language, that we can best describe objects and actions in terms of visual elements. On the other hand, our muscular impressions are so obscure and so little differentiated that there are few terms descriptive of purely motor experience. Hence teaching has too great a tendency to rely on the eye and on verbal description of visual impressions. This, at any rate so far as teaching practical activities is concerned, is a mistake, since in pursuits of that nature both visual and motor experiences are required to guide actions to a successful issue.

It is clear, then, that in teaching practical activities, although much can be done by demonstration and by instruction to give a good understanding of the nature of the task and how to set about accomplishing it, yet it is also true that a thorough knowledge of practical problems can only be attained through practical experience. The knowledge of the form of objects which is really valuable for practical purposes is most thoroughly acquired by drawing, painting, modelling, and carving similar forms. Precept and example will show what should be done and what is to be avoided, but there must be ample opportunity for practical work. Practice alone can give that element of practical experience and that basis of automatism that are essential to skilled action on things.

Perceptual and Motor Training combined in Practical Activities.

6. Practical activity, it is seen, has both its perceptual and its motor aspects, and these in skilled action are in most intimate and thorough correlation. Indeed, as has just been shown, they are to some extent interdependent on each other. It is obvious, then, that these two aspects should not be separated in teaching, but should be brought into closest relationship. Both aspects are essential to skilled action on the objects of one's environment, and both should be trained by means of practical action on such objects. The perceptual experience that is to be of value in practical activity is that which results from practical conduct and bears on practical conduct, and the movements to be trained must be correlated with such perceptual experience.

Hence, as Professor Royce says, "If you are to train the powers of perception, you must train the conduct of the person who is to learn how to perceive,"[1] and the

[1] *Outlines of Psychology*, p. 226.

evident corollary is that if you wish to train the power of acting skilfully with things you must train it in connexion with the perception of those things. Perception isolated from action leads to theoretic knowledge that has no appropriate motor responses correlated with it, and will result in a youth who may have encyclopaedic information about the things around him, but in the practical affairs of life is an awkward and inefficient bungler. In a word, he does not know the things; he only knows about them, and that is a very different matter. Similarly, to train movement apart from the endeavour to gain knowledge of objects and to turn them to some purpose of value will secure a motor machinery that has little or no bearing on the needs of life.

A system of physical exercises, such as free exercises, exercises with dumb-bells and wands, cannot, then, give a complete training in practical activity. Systems such as these seek by means of a complicated and systematic series of movements of arms, body, and legs to exercise every muscle in the body so that the motor centres can acquire the organisation for quick, easy, and orderly movement. Coordinated movements of the various muscles and muscle groups, it is true, can be acquired by such exercises. But it is an organisation that is isolated and disconnected from a knowledge of things and of practical purposes with reference to them. It is a nervous mechanism for the control of movement that has been trained *in vacuo*. A fencer practises lunging and parrying, but mere drill of this kind will not make him a fencer. Such mechanical exercises can only train the coordinating machinery of movement. It can teach him to make these movements, but not when to do the one and when the other. This latter can only be learnt by the actual engaging with an opponent whose actions have to be

watched and whose skill and intelligence can be defeated only by constructing some plan of attack or defence suited to the circumstances. The intelligent use of the mechanism of movement can be thoroughly trained only when it is exercised in gaining control over material, or objects, or opponents, whose continually changing state necessitates close perceptual attention, and when constructive imagination is required in the progressive attainment of the end.

The Nature of the Practical Pursuits of School.

7. It is evident, then, that the practical activities of school life should be pursuits and occupations in which intelligence and skill are required in the manipulation of some material, or in the contest with some antagonist. Nature herself indicates the lines education should follow.

Dual Aspect of Practical Pursuits.

As has been seen, there is a special period of growth for each centre, during which training will have its best effect. The development of each centre is marked by the instinctive impulse to exercise it. The child, boy, and youth is unceasingly and spontaneously active in handling objects, pulling them to pieces, constructing things, imitating the occupations of his elders, making crude representation of the forms of objects with paint or pencil, running, jumping, climbing, struggling with his companions, or joining with them in social games. Every object seems to impel him to exercise his activities upon it. Yet it is important to note that in such spontaneous pursuits it is not only his motor centres and muscles that are being developed. His intellectual, emotional, and social nature is expanding by means of these pursuits. He advances in knowledge of objects, and interests are aroused to give definite concrete form to his future efforts.

Shapes, colours, and sounds stir his admiration and lead him to express in some physical form his thoughts and emotions with respect to them. In the contests and games with his companions personal and social feelings are being awakened and exercised.

The spontaneous activities of childhood have, then, a dual aspect. On the one hand there is the mental side of interest, curiosity, admiration, self-assertion, and sympathy, out of which will develop the child's intellectual, aesthetic, moral, and social nature; on the other is the aspect of physical action by which he is impelled to realise the cravings of his nature and to express them in some physical form. These two sides of spontaneous activity must not, in training, be separated, if life through childhood and youth to manhood is to be an organic unity. The practical activities of school must be in close and intimate relation with the expanding intellectual, aesthetic, moral, and social life of the child, and must aid him in realising and in expressing that life to the full.

The Motor Aspect of Practical Pursuits of the School.

Since the centres for the larger movements of the body and limbs develop before those for the finer and more delicate movements it is evident that the practical pursuits of early childhood should be mainly those that call for the former kind of action. Before the age of seven children should not be allowed to engage in any work of a fine and delicate character. Children so young can only perform such movements slowly and awkwardly, and the time spent is out of all proportion to the advance made. More rapid advance in skill of this kind will be made when the children are older. Hence, writing, figuring, drawing on paper, and fine sewing should not be much in evidence in the infant school. The

Practical Activities of young Children.

young children should be taught to write and to draw on upright blackboards, with large free movements of the arm from the shoulder, and should continue on these lines for some considerable time until they have made some progress in the use of fingers and wrist. Larger movements of the body and limbs should be trained by action songs and recitations in which imitative and emotional gestures are used, by simple dances, by imitative and other games, and by simple modelling in sand and clay.

Practical Activities of older Pupils.

When the child leaves the infant school fine and delicate work with the hand should begin to take an increasingly prominent place in the practical exercises, though at no time should the larger movements of the arm and body and legs be neglected. Writing, figuring, and drawing on paper with pen and pencil should be begun and should be practised intensively, so that skill in these branches can be rapidly acquired. After this, drawing with coloured chalks should give place to drawing with the brush. Clay modelling should advance to finer forms of work, and cardboard modelling may begin as a preliminary to the more difficult wood-carving and handicrafts which should come later. Free-arm drawing should not be discontinued, but should be carried on side by side with pencil drawing and painting.[1]

Larger movements of the body should be trained by games and contests. For the younger pupils there should be running, jumping, catching, and ball games. For the elder fencing, wrestling, fives, hockey, cricket, and football.

Grace and ease of movement should also receive attention. Too many of the pupils of our schools are allowed to form bad habits of walking, sitting, and standing. The

[1] See Welton, *Principles and Methods of Teaching*, Chap. XIV., § 8.

action songs and simple dances of the kindergarten begin the training which should be continued in the upper school by gesture in recitation, by dramatic acting, and by slow and graceful movements performed to music. Quoit throwing and fencing, too, will do much to train ease and grace, if attention be paid to the attitudes and movements of the pupils in these exercises.

Intensive Practice of each branch of Practical Activity.

Each year, as has been seen, there should be one or two branches of practical activity intensively studied so that a considerable degree of skill may be acquired in a short time. The early period of practice is the time for intensive study, so that each year should see begun some new form of practical work which should be made the prominent feature of that year's training. No valuable form of activity, however, should be dropped. Some of the exercises, such as cardboard modelling, are entirely of a preparatory character and so will give place to others, but those that can advance to higher and more difficult forms of skill should be continued.

Wide range of School Practical Activities.

It is essential that the skill trained should not be of any narrow or limited character, but broad and various, and capable of advancing to higher and more complex forms. The hand should be given control over chalk, pencil, pen, and brush; over clay, hard and soft woods, and metals; in working with instruments or with the fingers alone. Football, cricket, hockey, fives, swimming, fencing, wrestling, dancing will give great diversity of leg, arm, and body control. Moreover, all these occupations, games, and contests give ample scope for continuous development to more difficult forms of skill and for the exercise of intelligence. In none of them is there any monotonous repetition of a simple movement easily learnt as there

is in such exercises as paper cutting and folding and free arm drill.

Drill preparatory to Practical Pursuits.

Careful instruction in the elements of movements and frequent practice of these elements to acquire automatic and perfect action have been seen to be essential to advance in skill. Hence, drill in the elements of movement is a necessary part of the instruction in practical activity. Such exercises, however, if they are to be of real value in practical pursuits, should bear as closely as possible on and lead up to the movements required in real occupations, games, and contests. There should be breathing, walking, running, jumping, fencing, and wrestling drill to give instruction in the elements of attitude and movement used in the games and contests and to perfect them by repeated practice. These formal exercises should be thorough and methodical, and should advance in difficulty and complexity, but, as has been emphasised already, should only be regarded as preparatory to real practical activities to follow. Breathing exercises, for example, should at first be taught and practised by themselves, but afterwards should be combined with exercises in running and jumping, and with recitation and singing. Similarly, walking, running, jumping, balancing, bending, and lunging will at first be practised independently, but the function of these exercises is to train a skill which can be used and should be practised in the real activities of games and contests. It is in this latter form of activity that the training in skill is fully and completely perfected. Formal exercises only train the elements which afterwards should be combined into practical activities carried on under the guidance of the intelligence.

The development of the mental side of practical activity, moreover, is as important as is the development of the

motor element. The skill which is being gradually acquired should be used as a means of furthering intellectual, aesthetic, and social ends, and of making the most and the best of the intellectual curiosity, the admiration for shape, colour, and sound, and the personal and social elements that are actively showing themselves.

The Mental Aspect of Practical Pursuits of the School.

In handicrafts and practical measurements a knowledge of exact form and of materials should be aimed at as well as practical skill. In drawing and painting, the forms and colours of flowers, leaves, stems, and roots, of butterflies and moths, of the feathers, claws, and beaks of birds, and of shells and pebbles should be examined, and the knowledge gained will be all the more exact and thorough because of the care induced by the drawing and painting.

Practical Pursuits as a means to Knowledge.

Plants and animals, however, appeal not only to intellectual curiosity, but also to the innate sense of the beautiful. Painting and drawing, therefore, besides being the instruments of knowledge should be a means of encouraging the appreciation of the beautiful in form and colour. Of these qualities, Professor Welton says, "a child has an appreciation, but his appreciation is crude. He loves gaudy colours and strong contrasts, and his feeling for grace of form is even more embryonic than that for beauty of colour. But he delights in a beautiful flower, or butterfly, or bird, and, indeed, his expression of delight when he names such things 'pretty' is generally well deserved. He does not know why they please him: he only feels the gratification. But there is a germ from which an educated taste may spring. In a few souls it springs spontaneously and irresistibly; they are the great artists of the world. In the

Practical Pursuits in Art.

majority of souls it requires careful training, or it will develop but little, if at all—especially in a life passed amidst the generally grimy and ugly features of too many modern towns. It is not meant that the school should attempt to turn all its pupils into artists, but simply that it should aim at leading each to a higher level of taste, and thus should give an added value and interest to life."[1]

The training of a taste for beautiful forms and colours should thus be an aspect of the practical activities of the school, and the expression of beauty in thought and emotion should, in no less a measure, be a part of their aim. In a simple way, the action songs and recitations and the dances of the infant school lead the child to realise more fully the meaning of the words and to enter more whole-heartedly into the emotions. In a more refined and restrained way, by means of the modulation of the voice and by appropriate gestures, should the older pupils give expression to thought and feeling and so gain a fuller appreciation of the noble literature of our country. In reading dramatic literature the pupils should at times act a scene with appropriate gestures and movements.

Practical Pursuits and Moral and Social Development.

It is, however, in the contests and games that the social and moral nature of the pupils is most completely and fully stimulated. Contests and games demand hardihood, courage, and patience. The power to take a beating with a smile and to win without a display of triumph is soon acquired when a healthy spirit of sportsmanship prevails.

Above all, games and contests are essentially at once competitive and co-operative. In manual occupations skill is exercised in gaining control over inanimate soulless matter, but in games and contests there is the strife of opposing

[1] *Principles of Teaching*, p. 488.

skills and intelligences and the blending of many minds into a united company. From this co-operation and competition of human elements valuable experience of human nature is acquired. Just as by manual occupations the pupils acqure a thoroughly practical experience of the material they are working on, so by games and contests do they gain an intensely practical knowledge of the many aspects and modes of human nature, and thus learn tact and judgment in dealing with their fellows. In no other way than in earnest and keen, yet friendly, competition and co-operation in games and contests that arouse feelings and demand an exercise of intelligence and skill can there be obtained so practical, so thorough, and so intimate a knowledge of human nature in many aspects—a knowledge that will stand the pupils in good stead in the keener competition and more strenuous co-operation of real life in the future.

It is good that contests and games should arouse feelings of all kinds, some good and some of a baser kind. Control over feelings is necessary for social well-being, and control can only be trained if there are opportunities for the display of feeling with encouragement and inducement to restrain the display. When there is a good, healthy, sportsmanlike tone among the boys, and when the contests and games are under the more or less general supervision of a tactful yet firm instructor, displays of conceit and temper will meet with universal ridicule and contempt, and offenders will quickly learn that hearty good-will and friendliness are the most potent paths to social welfare.

It may, indeed, be truly said that the games of a school give an apprenticeship to real life such as no other school pursuit can give. In no other study or occupation is a pupil at such close grip with opposing human nature, and in no other occupation is there so great a demand for

self-control, self-denial, patience, firmness, good temper, and hearty good-will. The class-room studies and the manual occupations are largely individualistic in their tendencies. They train each pupil to make the most of himself by himself and for himself. The essential factor of many games is that each member of a side must work in friendly rivalry with others under a properly constituted authority and for the common weal.

Games and contests, then, should form part of every boy and girl's education. We have seen that they are essential to a comprehensive training in practical skill. It will be shown in a later chapter that they are a means to vigorous health and growth. It is, however, on the moral and social ground that we would now urge their inclusion in the school curriculum. They are, above all other pursuits, the most suitable means for training many of the elements of a strong, self-reliant, yet self-controlled manhood. In the contest of mind with mind, skill against skill as well as strength against strength, are developed those human qualities that are essential in the battle of life. Surely, then, games and contests should form an important element in the life of every kind of school, not only because of the physical and practical benefits that accrue therefrom, but, what is of greater importance to our national character, on account of the moral and social training given by them.

Organisation of Instructors of Practical Activities.

8. The practical activities of the infant and the lower school will be of so elementary a kind that the class teacher will be well able to give instruction in all of them, and thus the singleness of life which is so characteristic of the young can be maintained. Those of the upper school, however, should be so advanced and so technical as to require for each group of allied activities a teacher who has a keen interest in one special branch

and has made a special study of it and of the modes of teaching it. The instruction in practical measurements and plan-making should be given by the teacher of mathematics. Voice-training, elocution, and music should be taken by the teacher of English literature. Drawing and painting from objects will be partly taught by the teacher of natural history, but, especially on its artistic side, will be taken in conjunction with carving, modelling, and handicraft by the instructor in art. Each main group of subjects should, in the upper school, have its special teacher, and in some cases its special room. In a large school there should be an art room specially equipped with blackboards, easles, drawing desks, and other apparatus needed for thorough instruction in drawing and painting. Handicraft and carving must of necessity have their own workshop furnished with benches and supplied with the necessary tools.

Where all the subjects of the school curriculum are taught by the class teacher, unity of discipline and to some extent of teaching method are secured, at least during each successive year while one teacher stays with a class. Usually, however, the end of each school year finds the old discipline, methods, and interests torn up by the roots, and a new discipline, new methods, and new interests planted in their place. The harmonious and regular development of the child is thus subjected to an annual disturbance, and his mode of thought and line of interest in several subjects may suffer a very considerable upheaval.

When a specialist teacher gives instruction in one branch of activities throughout the school, there is to set against the unity of discipline and of method in each successive year a keener interest, a more extensive and deeper knowledge, and a higher degree of practical skill

on the part of the teacher, which should bear fruit in a greater freshness, vivacity, and life in the teaching. But above all, since each branch of studies will be taught at all its stages by the same instructor, there will be no break of methods, of interests, and of thought at the end of each year. Instead, there will be secured in each group of subjects a consistency of method, a continuity of interest, and a methodical and regular advance on definite lines throughout the whole course, which are of greater educational value than a somewhat hypothetical correlation of the different branches of study in each successive year.

In a small school, where there are only one or two teachers, specialisation in the teaching on these lines is difficult, but even where there are only two teachers a grouping of subjects according to the aptitudes of the teachers is better than a permanent division of the school into two parts, each of which suffers from the special weaknesses of its own teacher and does not benefit by the special proficiency of the other. In large schools, where a large staff is engaged, each teacher should be appointed on account of his knowledge of and aptitude for some one branch of activity. In this way only will the most and the best be made of the few years of school life and a wide knowledge, generous and fruitful interests, and a high degree of physical skill be attained by the pupils.

Where such specialisation of teaching is carried out the pupils should be divided into 'houses' for social pursuits and each house placed under the charge of a member of the staff. Each house should contain pupils of all ages, so that the older boys may feel some responsibility for the younger, and the younger learn the lesson of social obedience by being under the authority of one of their own order. The teacher in charge should interest himself in each boy, talk to each boy of his school life and the

employment of his leisure time, and give encouragement and stimulus by kindly advice. He should organise the social life of the boys of his house by promoting societies for leisure hour pursuits, and should supervise and encourage their sports and games.

Though each member of the staff should interest himself in the sports and games of the boys of his house and exercise general supervision over them, yet in a large school there is need for a special teacher to give instruction in games. The games instructor should be keenly interested in games and contests suitable for pupils of all ages and should have a wide knowledge of them. He should organise simple games suited to the strength and skill of the young pupils, and he should give instruction in batting, bowling, fielding, football, hockey, and fives to the older boys.

In the gymnasium or school yard he should give instruction and frequent practice in the elements of action, in breathing, walking, running, jumping, climbing, fencing, and wrestling. While allowing the pupils to organise and manage their sports and games as much as possible for themselves, he should frequently be present as general adviser and mentor. He, no less than the master of each house, should endeavour to introduce into the sports, games, and contests, no spirit of mechanical routine or forced drudgery, but one of keen sportsmanship, healthy rivalry, and an enthusiasm for higher proficiency. He should, while making use of the natural sporting and play instincts, see that the games and contests are not merely recreative play, but a serious training of skill, of practical intelligence, and of character.

CHAPTER VI.

THE ORGANIC LIFE OF THE BODY.

Health and the Organic Functions.

1. The first aim of physical education, it has been stated, is the development of a sound and vigorous constitution. Health is the first necessity, for on it depends not only the vigour of our physical labour, but also the strenuousness of our moral and intellectual life. It must, therefore, be a consideration of the first importance to discover those conditions that will promote a healthy life and, for the young, a vigorous and harmonious growth.

The mental and physical vigour of the organism has been shown to be dependent on the harmonious activity of all the organs of the body. Each organ has its own special work. Some aid in supplying the tissues with the nutriment and oxygen from which living substance is constructed and the energy for life and work is obtained; others help in the removal of the waste products which result from the vital processes and functional activity of the bodily organs. Each organ is dependent on all the others for its life and functional power. The faulty action of any one organ is reflected in the disordered life and action of all. Hence, in considering the conditions for healthy life and growth, it is necessary to know, at least

in broad outline, the action of each part of the bodily machine, how the parts work in relation to each other and how the activity of each and all is adapted to external conditions and to internal needs. The anatomical structure of the body as a whole, and of each separate organ, does not greatly concern us. In considering conditions for health it is the work of each organ, not its appearance or structure, that is important. It is assumed, however, that the reader knows the position in the body of such organs as the heart, lungs, liver, and kidneys.

The Blood.

2. Every organ feeds on the blood. Each draws from it the substances necessary for building up its own peculiar form of living tissue, and hands back the waste products of tissue decomposition. The blood is thus the common source of life and energy for all the tissues, and the common sewer for draining away their impurities. Yet, though each organ feeds on the blood, each contributes something to the power of the blood to support life and assist growth. The digestive system gives it nutrition, the lungs oxygen, the heart circulates it through the body, and the kidneys, lungs, and skin cleanse it of its impurities. Just as the central nervous system unites the senses and muscles into harmonious action with respect to the external world, so in some measure does the blood bind the tissues into a common organic life. For by means of the common channel of the blood every organ lives and functions by the activity of all the others. The work of each of the organs, then, centres in its action on the blood. Hence it is desirable to begin the discussion of the organic functions by considering the nature of the blood, and throughout that examination to keep in mind that the blood is one medium through which the activity of any organ can influence the life and growth of the body in general.

The Blood Plasma.

The blood consists of an almost colourless liquid, the plasma, in which float a large number of small bodies, called the red and white corpuscles. The plasma contains the nutriment of the blood—the albumen, sugars, and fats—from which the cells build their living tissue and replenish their energy. It also contains waste products that have been poured into the blood, the principal of which are kreatin, urea, and lactic acid.

The Red Corpuscles.

The red corpuscles give the blood its red colour. They are extremely small, biconcave discs, composed of a groundwork of protoplasm which contains a red-coloured substance called haemoglobin. The red corpuscles are the oxygen-carriers for the tissues, taking oxygen from the air in the lungs and giving it up to the tissues. They have this function on account of the peculiar action of haemoglobin with respect to oxygen. Haemoglobin has a strong affinity for oxygen, and in the presence of free oxygen unites with it, forming oxy-haemoglobin. The change is denoted by an alteration in colour. The purple haemoglobin becomes the bright scarlet oxy-haemoglobin. Oxy-haemoglobin, however, is a very unstable compound and readily parts with its surplus oxygen in the presence of substances that have a strong affinity for oxygen.

This double action, of taking up oxygen and parting with it, is performed in the body by the haemoglobin of the red corpuscles. When the blood is passing around the air cells of the lungs, the red corpuscles take up the free oxygen from the air in the lungs, and the blood becomes bright scarlet in colour. But when the oxygenated blood flows through the tissues, the reverse action takes place. The tissues are demanding oxygen for building up living substance and rob the red corpuscles of their surplus store.

The bright scarlet colour of the blood thereupon changes to purple. Thus, the blood flowing from the lungs to the tissues is oxygenated and of a bright scarlet colour, and is called arterial; that flowing from the tissues to the lungs is de-oxygenated and purple in colour, and is called venous.

The White Corpuscles.

The white corpuscles are far less numerous than the red. They are typical living cells with protoplasm and nucleus. Not much is known about the work of the white corpuscles, though there is much conjecture as to its nature. Their presence in the blood seems in some way to influence the process by which the tissues absorb nutriment from the blood. It is also thought that they feed on the germs of disease that have entered the blood. If that be so the activity of the white corpuscles is an important factor in resisting disease.

The Circulation of the Blood.

3. The blood flows through the circulatory system, which consists of the heart, arteries, capillaries, and veins. Its flow is due to the action of the heart, which is a double pump forcing the blood in two main streams through the body. One stream flows from the right side of the heart to the lungs and back to the left side of the heart. The other leaves the left side of the heart, flows through the tissues of the body generally and back to the right side of the heart. In the former stream the venous blood is oxygenated; in the latter it parts with its oxygen and nutrition to the tissues and receives in their place waste products. Branches of this latter stream, too, flow through the digestive system, where nutrition is absorbed into the blood; and through the kidneys and skin, where impurities are withdrawn.

The Arteries.

The blood is carried to the tissues by the arteries, which break up into smaller and smaller vessels before they enter the substance of the tissues. The arteries are not passive channels. By the action of

their walls they influence very largely the quantity of blood flowing through them. In the walls of the arteries are two layers of tissue of considerable importance: one is a band of muscular fibres wrapped round the artery, the other is a layer of elastic tissue. By the contraction or relaxation of the muscular fibres the size of the artery can be diminished or increased; but always the elastic fibres tend to bring the artery back to its normal position. The arteries thus have a structure by which the flow of blood to the body generally, or to any particular organ, can be regulated. It will be seen later how this regulation of flow by the arteries is automatic and depends on the needs of the tissues.

The Capillaries.

In the tissues the arteries break up into a network of hair-like capillaries which permeate every part of their substance. It is in the capillaries that the blood performs its function of nourishing the cells and removing their waste products. The walls of the capillaries are extremely thin, and readily permit the plasma to pass through them. The plasma thus directly surrounds the cells and fills up the interstices between them. It is here known as *lymph*. A continuous interchange of material takes place between the cells and the blood in the capillaries by way of the lymph as intermediary. Oxygen and nutrition pass from the blood to the cells, while the cells hand back creatin, lactic acid, and carbonic acid to the blood.

The Veins.

The blood having passed through the capillaries, where it has been despoiled of its oxygen and some part of its nutrition and fouled by waste products, is collected into the veins, which bring it back to the heart again.

4. In its passage through the lungs the blood takes up oxygen from the air. It also loses there the carbonic acid

which it has absorbed from the tissues. Thus in the lungs there is a mutual exchange of gases between the air and the blood. The air loses oxygen and takes up carbonic acid: the blood gains oxygen and loses carbonic acid. In the lungs, then, the blood is both oxygenated and partly purified.

The Respiratory System.

The structure of the lungs is suited to a rapid exchange of gases, for in the lungs a large surface of air is brought into proximity to a large surface of blood. The wind-pipe, or trachea, divides first into two bronchial tubes, called the *bronchi*. These divide repeatedly into smaller and smaller tubes, which finally become fine twig-like passages. Each of these twig-like passages expands at its end into a collection of air cells or chambers, in appearance like a cluster of grapes. It is in these air cells that the exchange of gases takes place. The air cells have extremely thin walls, and surrounding each air chamber is a fine close network of capillaries. The blood is thus separated from the air only by the thin walls of the capillaries and air cells. Interchange of gases can, then, take place by diffusion through the thin medium separating blood and air.

The Air Cells of the Lungs.

The air which leaves the lungs thus contains more carbonic acid and less oxygen than the air which enters. It is also saturated with moisture, and its temperature approximates to the internal temperature of the body. Moreover, organic substances are carried by the air from the sides of the air passages. These organic substances in the heat and moisture of a badly ventilated room rapidly decompose and give rise to a fetid, stuffy smell. These properties make air which has been breathed highly injurious to health, and it will be the work of a later chapter to show how foul air

Properties of Expired Air.

is to be removed from the rooms of a school and fresh air brought into them.

The Mechanism of Respiration.

Oxygen is a vital necessity to the vigorous life and growth of the tissues, especially during active exercise. Hence it is desirable to encourage the growth of the chest and to train in our pupils the habit of deep breathing. In doing this, whether by breathing exercises or by active games, the teacher should know how the walls and base of the chest act in inspiration and expiration.

The air is drawn into the lungs by an enlargement of the chest. The air cells expand, and consequently air rushes into the lungs. Expiration is mainly the result of the collapse of the chest to its original position.

The chest is enlarged by the combined action of the intercostal muscles—that is the muscles between the ribs—and the diaphragm, which is a large muscular plate separating the cavity of the chest from the abdomen.

The diaphragm is convex towards the chest. The contraction of its muscles, therefore, will cause it to become flatter. By this action the cavity of the chest is enlarged, and air is drawn into the lungs. At the same time, the contraction of the diaphragm presses it down on the contents of the abdomen. Consequently the walls of the abdomen are forced out. Hence it comes about that the abdomen moves outward and inward to the inspiration and expiration of the air.

The intercostal muscles act on the walls of the chest. The ribs are fixed at their spinal end and incline in a downward sloping arch towards the breastbone, to which they are attached by means of cartilage. There are twelve ribs on each side, and they increase in length, in slope, and in curvature from above downward as far as the seventh or eighth rib. The chest thus has its greatest

cross section across the line of the seventh or eighth rib. Between the ribs are muscular fibres running obliquely downward.

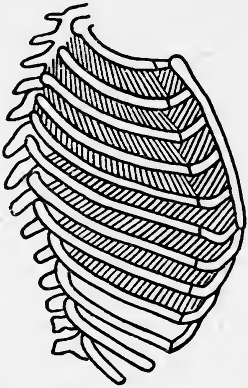

Fig. 7.—The Side of the Chest.

Showing the twelve Ribs, attached to the twelve Dorsal Vertebrae: Note how the Cartilages increase in length. The muscles joining the ribs are the Intercostals, the External Intercostals in the first four intercostal spaces, the Internal Intercostals in the second four intercostal spaces and between the Costal Cartilages.

The contraction of the intercostal muscles pulls the ribs upward and forward. Consequently the chest is enlarged from behind forward, and from right to left, especially in the line of the seventh or eighth rib. Since the middle and lower parts of the chest have a greater air capacity than the upper part, the action of the diaphragm and of the middle and lower ribs is most important in securing deep breathing. Later we shall consider how chest capacity should be developed and the habit of deep breathing formed.

5. The digestive system provides the nutritive element of the blood plasma—the albumin, sugars, and fats from which the tissues build up their living substance. The

principle of its action is to change the various food substances into a form in which they can be readily diffused through the walls of the digestive organs, and so pass into the blood.

The Digestive System.

Such action is known as digestion. The process of digestion is a chemical action on the food substances, and is performed by various digestive juices secreted from the blood by the digestive glands in different parts of the digestive system.

The Process of Digestion.

The food substances consist mainly of organic substances, and of water and salts. The organic foodstuffs are divided into nitrogenous or proteid substances, such as flesh and the albumen of an egg; carbohydrates, such as sugar and the starches of flour and potatoes; and fats, such as suet and butter. The digestion of the proteids, of the carbohydrates, and of the fats is performed in different parts of the digestive system. The solid food is first masticated in the mouth, where it should be thoroughly reduced to small pieces by the incisor and grinder teeth. Mastication is aided by the saliva from the salivary glands inside the lower jaw and underneath the tongue. The saliva, besides helping mastication, acts on the carbohydrates of the food. It changes them into a more diffusible form known as grape sugar. The first process of digestion, then, begins in the mouth.

The masticated and partly digested food is passed down the gullet into the stomach. Here it undergoes further change. It is churned to and fro by the muscular action of the walls of the stomach, and in this way is thoroughly mixed with the gastric juice which is secreted by glands in those walls. The gastric juice acts on the proteid foods and changes them to simpler substances, called peptones, which can pass through the walls of the intestines and so into the blood.

The food leaves the stomach in a thick pea-soup-like form and passes into the small intestine. Here it mixes with the bile from the liver and with the pancreatic juice from the pancreas. These act on the carbohydrates and the fats. The digestion of the carbohydrates, which had been arrested in the stomach, then recommences, while that of the fats begins.

The digestion of fats is different from that of the proteids and carbohydrates. It proceeds, not so much by changing the fats into chemically simpler bodies, but by breaking the globules of fat into extremely small particles. A similar action is seen when drops of oil are violently shaken in water. The liquid becomes white and creamy owing to the drops of oil breaking up into an extremely large number of very small droplets. In this form the liquid is called an emulsion. The digestion of fats is of this nature. The bile and pancreatic juices act on the globules of fat and turn them into a white creamy emulsion. In this form the fats are passed into the blood.

Reserve Food Substances.

The food, having been digested in this manner, is passed into the blood and enriches the plasma. The nutriment, however, is not wholly retained in the blood. Part of it, especially the sugars and fats, is absorbed by some of the tissues and converted into a reserve supply for future use. The liver, the muscles, and the connective tissues that bind the organs together are the tissues principally concerned in the storing of reserve foods.

The blood, rich with its absorbed food, passes straight from the digestive tract to the liver, through the substance of which it permeates in a network of fine capillaries. The liver cells absorb the excess of sugar from the blood and convert it into glycogen or animal starch. This remains stored in the cells of the liver until the nutritive condition

of the blood so changes that the glycogen is taken back again into it for the purpose of general nutrition. In a similar way glycogen is stored by the cells of the muscular tissue.

Reserve food is largely stored in the form of fat. Almost all the tissues take part in this action, and connective tissue is especially prominent in the work. Fatty tissue is formed not only from the emulsified fats passed into the blood, but also from the carbohydrates and even from the proteids. It is well known, for example, that porridge, bread, potatoes, and sugar, which are carbohydrates, are fattening. The fat globules stored in the cells must, then, be manufactured by the cells themselves from the nutritive plasma, just as glycogen is manufactured by the liver cells from the sugar of the blood.

The body, then, contains reserve stores of carbohydrates and fats which can be drawn upon when the nutritive quality of the blood deteriorates. At such times these substances are the first to disappear. Thus, during prolonged fasting, or during illness, or at those times of energetic work when the tissues are using up food material faster than the digestive system can supply it, these food reserves are drawn upon to enrich the blood. A periodic supply of nutrition is by this means converted into a constant one.

The Excretory System.

6. The impurities resulting from the life and work of the tissues are constantly being drained into the blood and must, therefore, be constantly removed unless the activity of the tissues is to be hindered. The most important impurities are carbonic acid and urea. Besides these the decomposition of the living substance results in the formation of water, heat, and a variety of salts. The carbonic acid is removed by the lungs, by which channel some

of the water and heat also escape; a small quantity of salts and a large amount of water and heat are discharged through the skin; while practically all the urea, most of the salts, and a large proportion of water are removed by the kidneys.

The action of the lungs in removing the carbonic acid has already been considered. It remains to examine the action of the skin and kidneys.

The Skin. The skin consists of a number of layers. The outside layer is hard and horny, and protects the body from injury. The outermost scales of this layer are constantly being shed or rubbed off in the form of flakes. Underneath is a softer layer of cells that

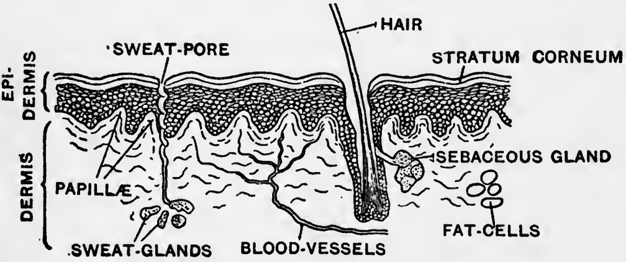

Fig. 8.

are continually growing in size and increasing in number by division. The cells of this layer are thus gradually thrust outward, and are transformed into hard, flattened plates to replace those shed from the outer skin.

The innermost layer is a soft underskin of connective tissue which binds the skin to the structures underneath. It is plentifully supplied with blood vessels, which break up into a system of capillary networks and loops. In connexion with this capillary network is a large number of

sweat glands. These are tube-like structures curled up into knots, from each of which a duct passes through the outer skin to the exterior of the body. Round the knot is the close network of capillaries, so that a large surface of blood is subjected to the action of the gland, which extracts water and salts. These are exuded through the duct and form sweat or perspiration.

Excretion from the skin is constantly going on, though it varies in amount from time to time. During active exercise, for example, when the skin is suffused with blood, excretion proceeds rapidly, so rapidly in fact that the sweat collects into visible drops. Usually, however, the sweat evaporates as quickly as it is formed, but leaves behind on the skin a small deposit of salts.

The skin also removes the greater part of the excess of heat produced by tissue decomposition. The skin, being plentifully supplied with blood-vessels in the form of networks of capillaries, brings a large amount of blood into proximity to the cooler air. Heat is thus lost; the amount depending partly on the difference between the temperature of the blood and that of the air, and partly on the quantity of blood circulating through the skin. In this way the temperature of the body is kept fairly constant.

The Kidneys.

The kidneys remove practically all the urea, most of the salts, and a large portion of water. Urea is a nitrogenous compound and is the only form in which the nitrogenous element of tissue decomposition leaves the body. It is not, however, formed by the tissues themselves. It is probable that a more complex nitrogenous substance is formed in the tissues, which is transformed into urea by the action of the liver cells. The urea is then removed from the blood by the cells of the kidneys.

The Nervous Centres for the Control of the Organic Functions.

7. The digestive, respiratory, and excretory systems, then, by their action on the blood minister to the wants of all the tissues. There is, however, one other organ whose action is of extreme importance in the organic life of the body. This organ is the nervous centre—or rather collection of centres—which adapts the activity of the organs to external conditions and internal needs.

The conditions of tissue life are not always the same. A change in the temperature of the air affects the action of the skin. A change from rest to active mental or physical labour increases the quantity of waste products produced and the demand of nerve or muscle cells for oxygen and nutrition. Periodically, digestive juices are required to deal with the food. Under such constantly changing conditions the organs of the body should not work in a uniform manner. Unless the bodily machine is to become deranged, there must be some mechanism by which the activity of the various organs can be adapted to the changing conditions. If such adaptation did not take place, if the circulation, respiration, and other organic functions were not regulated to the needs of the system, the same uniform stream of blood would flow to each organ irrespective of local and general needs. Brain or muscle, digestive organs, or skin, whether at work or at rest, whether needing much or little, would receive the same uniform ration of oxygen and nutrition and the same uniform removal of waste products.

The Sympathetic System.

The nervous system for regulating the organic functions of the body is, in some respects, separate from the system that controls the organs of sense and movement, and is called the *Sympathetic Nervous System.* It consists of two nerve cords, interrupted by ganglia of nerve cells lying in front

of the backbone and passing down the whole length of it. The nerves passing from these cords and ganglia join with the spinal nerves and with a large nerve from the bulb called the *pneumo-gastric*. The whole forms a complicated network of nerves, which finally pass to the viscera of the chest and abdomen, and especially to the muscular walls of the arteries of the body. The sympathetic system is thus in close connexion with the cerebro-spinal system, and it is highly probable that some form of local control of the organic functions is exercised by means of the ganglia of the sympathetic system and the spinal centres of the cerebro-spinal system.

The Organic Centre in the Bulb.

The general control of the whole organic functions, however, lies in the bulb. This centre is situated on the main sensory and motor paths to the cerebral hemispheres. It is thus in connexion with every muscular and sensory area of the body. On the other hand, by means of the pneumo-gastric nerve and the distributive nerves of the sympathetic system, it is in connexion with all the viscera and the blood-vessels. Afferent stimuli, then, from any part of the body can, through the organic centre in the bulb, influence respiration, circulation, or other organic functioning.

The organic centre, with the exception of that part which controls respiration, does not act under the control of the cerebral hemispheres. We cannot will to make the heart beat faster or to digest our food. We can, however, control our breathing to some extent, though we cannot entirely suspend it at will. The organic centre, however, is in some kind of connexion with the cerebral hemispheres, for conscious states influence the beating of the heart, the arterial circulation and respiration, and afferent stimuli from the viscera contribute largely to the organic feeling

of health or illness that forms so important, yet so undiscriminated, a background to conscious life.

The Control of the Heart.

The most important function of the organic centre is to control the circulation of the blood in accordance with the needs of particular organs or of the body as a whole. The circulation is modified by altering the beating of the heart and by contracting or relaxing the arteries which supply the organs with blood.

The heart is composed of muscular tissue, and its beat is the contraction of its walls, by which the enclosed space is reduced in size and the blood is forced out. Usually muscular contraction is due to a nerve stimulus, but the rhythmic beating of the heart is not caused in this way. The muscular substance of the heart possesses in itself the power to contract rhythmically. The continuance of this power will, of course, depend on the regular supply of oxygen and nutrition to provide for the nutritive changes and to supply the energy necessary for rhythmic contraction. Any falling off in the nutrition of the muscular substance of the heart at once affects the beating. It becomes irregular and weak. A similar result follows if the blood contains toxic substances, such as an excess of waste products. These substances have a numbing, paralysing effect on tissue action, and so, by diminishing nutritive changes in the heart, impair its beating.

Though the rhythmic beating of the heart is not due to the action of the organic centre, yet it may be modified by nervous stimuli from that centre. The organic centre supplies the heart with two sets of nerve fibres. By means of one set the beating of the heart can be made quicker and stronger, by the other slower and weaker. The organic centre can thus augment or inhibit the activity of the heart. In what way the centre acts depends, of

course, on the kind of nerve currents reaching it. A severe pain, an intense emotion, a blow on the stomach, each results in inhibitory impulses which may become so intense as actually to cause cessation of the heart beat and so produce fainting. Mental and muscular exercise, on the contrary, affects the centre so as to augment the activity of the heart and bring about a more vigorous circulation. So intimately is the organic centre in relation, directly or indirectly, with the whole bodily organism that the heart responds to almost every change that takes place in any part of the body.

The Control of the Arterial Circulation.

The flow of blood through the arteries is regulated on a slightly different plan from that by which the heart-beat is affected. The muscular coating of the arteries is plentifully supplied with nerve-fibres from the sympathetic system. Ordinarily the arteries are in a state of slight contraction due to continuous nerve stimuli, probably from the spinal centres or from the ganglia of the sympathetic system. Excitatory impulses will thus cause further contraction and produce a diminished flow of blood through the artery. A weakening of the nervous stimulus, on the other hand, will have the opposite effect of relaxing the artery and producing an increased flow of blood through it.

The flow of blood to any organ can be adapted to the needs of that organ by means of this action of the organic centre. The presence of food in the mouth, the sight or smell of food, or even the thought of it, affects the organic centre in such a way that the arteries to the digestive glands in the mouth and stomach are relaxed and the circulation through the digestive tract is greatly increased. The digestive glands are also stimulated to activity by efferent impulses from the organic centre. Hence, digestive juices are secreted and poured into the digestive tract in

readiness for the food about to be eaten. In a similar way the flow of blood to an organ in vigorous action is increased. The increased circulation through the working organ thus meets the demand for an improved nutrition and for a more rapid removal of waste products.

The circulation is thus modified according to the needs of the various organs. During a meal, and immediately after it, much of the blood stream is diverted to the digestive organs; during physical labour to the muscles; during mental work to the brain. It is not advisable, therefore, in the interests of digestion, to play games or to study immediately after a good dinner.

One of the most important of the functions of the organic centre is to keep the body at a uniform temperature by regulating the supply of blood to the skin. Heat is continually being produced by the decomposition of living tissue. During exercise, however, the amount formed is much greater than that produced when the body is at rest. Also during hot weather radiation from the skin tends to diminish, and during cold weather to increase. Hence there is a need for adapting the radiation from the skin to the temperature of the air and to the condition of the tissues. In cold weather the arteries to the skin are contracted; consequently, less blood circulates in the skin and less heat is lost. In warm weather and during active exercise these arteries relax and the skin is suffused with blood; hence, radiation of heat increases. In this way, whether the body be at work or at rest, whether the weather be cold or hot, the temperature of the body is kept more or less uniform.

The Control of Respiration.

Respiration, as well as circulation, is under the control of the organic centre. The exchange of gases between the tissues and the air through the medium of the blood depends partly on the circulation of blood through the tissues and the lungs,

and partly on the amount of air brought into the lungs, that is on the frequency and the depth of breathing. Hence, to adapt the exchange of the gases to the needs of the system both the circulation and the respiration have to be modified coordinately.

Unlike the beating of the heart, respiration is the direct effect of nervous stimulation. Rhythmic inspiration and expiration are produced by rhythmic nervous impulses from the organic centre. Respiration, therefore, is open to many influences from all parts of the system. Emotion, pain, concentrated intellectual work, a dash of cold water on the skin, irritation in the nasal or bronchial passages, all cause modifications in breathing. In these cases afferent stimuli reach the organic centre and result in modifying the rhythmic impulses to the lungs.

The organic centre, however, not only responds to afferent stimuli, but also to the condition of the blood. Just as the quality of the blood affects the activity of the muscles of the heart so it influences the activity of the cells of the organic centre. Venous blood, that is blood underoxygenated and containing an excess of carbonic acid, causes an increased activity in that part of the centre which controls breathing. As the venous character of the blood increases, the activity of the centre becomes more and more violent. Such a state is seen in breathlessness, when, it is evident, the centre is convulsively attempting to deepen and quicken the breathing.

The state of the blood thus affects respiration. But the venous character of the blood is a measure of the activity of the tissues. Hence respiration adapts itself, through the medium of the blood and the organic centre, to the state of rest or action of the body. When the body is in repose breathing is quiet; with exercise it quickens; with violent exertion it becomes laboured. Breathlessness

is, then, a sign that the system has reached its limit of adaptability. It means that the respiratory mechanism is being strained beyond its capacity in trying to oxygenate the blood and to remove the carbonic acid with sufficient rapidity to meet the demands of the tissues.

Conditions for Healthy Life and Growth.

8. Sufficient account has been given of the organic functions and of the way in which they are adapted to the needs of the system to indicate the conditions for healthy life and growth. Primarily healthy life and growth depend on the quality of the blood and the vigour of the circulation. Hence whatever measures are taken for developing the body physically, they should all aim at bottom at improving the life-giving properties of the vital fluid.

The heart should be a sound muscular organ able to respond by vigorous and strong beating in times of energetic action. The blood should be nourishing. This depends on the food and digestion. Nourishment should be sufficient for life and growth. It should provide varied material for building up nerve, muscle, and bone. It should be easily digested, for the energy of food cannot become the energy of life and growth unless the food enters the blood and is built into living tissue. A child may become physically weak and mentally defective as much from bad feeding as from under-feeding.

The blood should be well oxygenated. For this the blood should be plentifully supplied with red corpuscles, the oxygen carriers for the tissues. Anaemic children are wanting in physical and mental vitality. They cannot respond with the boisterous energy that is a sign of healthy childhood. They are pale, hollow-eyed, and dull. Their nervous and muscular systems are starved for want of oxygen. The heart, too, is weakened, and circulation

suffers. Digestion is enfeebled. The slightest exertion brings on breathlessness and exhaustion. With such a condition of the blood vigorous growth is impossible.

The lungs, too, should be capacious and the breathing deep and well controlled. Energetic action should not easily bring on breathlessness; for breathlessness, if easily produced, is a sign either of poor lungs, weak heart, or anaemic blood. Respiratory failure may be due either to the lungs not bringing the air in sufficient quantities to the blood, or to the heart not forcing the blood sufficiently rapidly through the lungs, or to the inability of the blood to absorb sufficient oxygen. Hence, for oxygenating the blood during active work, and for the continuance of work in an energetic manner, capacious lungs, a strong heart, and blood rich in red corpuscles are essential.

It is needless to enlarge on the importance of breathing pure fresh air to oxygenate the blood.

The purity of the blood depends on the energetic action of the skin, lungs, and kidneys. Hence mental health and vigour depend on the health of these organs. Much of the languor, listlessness, and irritability that attend a sedentary life result from the faulty action of the excretory organs.

Thus, in the physical development of the young, food, fresh air, and the development of good lung capacity, a strong heart, and vigorous digestive and excretory systems are of great importance. Some of these concern the teacher and require, therefore, more detailed treatment.

The activity of the organs is under the control of the organic centre, which responds to external conditions and to internal needs. The conditions of a child's life, however, are to a large extent under the control of teachers and parents. Hence measures can be taken for promoting the activity of digestion, circulation, and excretion. Nutritive

changes throughout the whole body can thus be stimulated, and health and growth fostered. The kind of life favourable to the energetic functioning of the organic system is, then, of vital importance in physical education. Its general character has, in some measure, already been suggested. Exercise, it has been seen, promotes respiration and circulation and results in improved nutritive changes. It also increases the circulation through the skin and so tends to purify the blood. It will, however, be seen that relaxation, rest, and sleep are also important agencies in the development of the body. Hence, the kind and amount of exercise and of relaxation necessary to healthy life and growth should be fully considered in organising the life of a school.

Finally, there should be emphasised the connexion between the vigour of the organic activities and the mental development of the child. Mental life has its physical basis in the activity of the nerve cells of the cerebral hemispheres. Consequently, its vigour will depend on the quantity and the quality of the blood circulating through the brain. Impure blood, blood poor in oxygen and in nutriment, or a feeble circulation, have their effect in producing feebleness of conscious life. Under such conditions fatigue is more easily brought on and more slowly recovered from, and the vigour of mental life is never very great.

The organic life of the body, however, is reflected in consciousness in another way. Through the afferent fibres of the sympathetic system consciousness is influenced by the state of the body. These organic impressions are largely of an emotional character. They give us little precise knowledge concerning the state of the organs of the body, but they have a great influence on the general emotional tone of consciousness. Irritability, low spirits,

mental depression, and even melancholia pervade our mental life during ill health and bodily weakness, while bright and happy spirits and cheerfulness attend vigorous health.

It is evident, then, that the pervading mental tone is largely the outcome of bodily states. And the kind of mental tone determines very largely the lines of mental development. Feebleness of mental life, irritability, and low spirits beget a timid outlook on the world, and the child grows up lacking in that manliness, self-assertion, and self-confidence without which is no effective and successful living. On the other hand, cheerfulness, mental elasticity and vigour beget that boisterous, courageous, and manly outlook that welcomes difficulties and struggle and finds its greatest pleasure in hard-earned victory.

CHAPTER VII.

FATIGUE.

Continued Work followed by Fatigue.

1. The life of the tissues consists in the double process of elaborating complex living molecules from the nutrition and oxygen supplied by the blood and of the destruction of those molecules. At every moment of life, energy has to be supplied to the cells of the tissues to replace the energy lost by tissue decomposition. But during the active functioning of an organ energy is expended at a much more rapid rate than when the organ is at rest. The living substance is the storehouse of the energy of bodily work, and during muscular contraction and nervous excitation muscular and nervous tissue is rapidly decomposed to supply the energy for these forms of activity, just as coal must be continually burnt to supply the energy for the working of a steam-engine. Since, however, neither muscle nor nerve cells have an indefinite fund of energy, functioning must, if continued long enough and with sufficient vigour, result in a gradual exhaustion of tissue energy, and lead to a total disability to continue either muscular or nervous work.

Such a condition of the tissues would be one of total collapse, and recovery would involve the gradual rebuilding of the tissue substance, a process that would be very slow. Before such a state of exhaustion is reached, however, there are many obvious signs of discomfort, of strain, and of overwork.

After vigorous work has been prolonged for some time we become aware of a growing feeling of tiredness and inertia, a disinclination to continue, and a desire for rest. Our efforts lack that elasticity, brightness, and 'go' that mark our work when the mind and the body are fresh. Rest comes as a distinct relief. Attention to our work, however, though it begins to flag, can be forced. Work can still be carried on by deliberately ignoring these warnings, until a stage is reached in which both mind and body refuse to be driven. Attention can no longer be forced, nor the signs of distress ignored. Work then comes to an end from total inability to continue.

Nature of Fatigue.

2. It is evident that these sensations of fatigue and strain are produced by bodily conditions resulting from prolonged cell activity. The activity of the nerve cells of the cerebrum is influenced either through the blood stream or by incoming stimuli through the afferent nerves from the bodily organs.

Loss of Tissue Energy.

At a first glance one is apt to suggest that the bodily conditions of fatigue are due to increasing loss of power in the organs working, and there can be little doubt that loss of power is a factor in fatigue and yet more in exhaustion. But besides loss of power as a result of cell activity there is a continual and unceasing accumulation of waste products, the outcome of tissue decomposition. It is very probable that these products exercise some harmful influence on the activity of the cells in which they are present.

Toxic Action of Waste Products.

Many substances affect in one way or another the metabolism of the cells. Some stimulate the cell to increased activity; others have a paralysing effect and decrease cell activity. Most drugs act on the system in one of these two ways. Strychnine, for example, stimulates the action

of the nerve cells, and when taken in large quantities leads to violent convulsions. On the other hand, tobacco diminishes the activity of the cells. It has already been shown how the waste products of tissue destruction affect the action both of the heart and of the centre of respiration. Hence it is very probable that the waste products of tissue life and functioning have a harmful effect on the activity of nerve and muscle cells, exerting a numbing influence, and, in large quantities, altogether paralysing their functioning power. That the waste products are harmful is suggested by the facts that the excretory system of lungs, skin, and kidneys exists for the purpose of ridding the body of them, and that any weakness or disease which causes deficient excretory action has very pronounced mental and bodily symptoms.

Nervous Tissue most sensitive to Toxic Agents.

Since the life processes of all kinds of cells are in the main very similar to each other, it is very likely that the harmful effects of waste products is felt by all tissues. But since differentiation of function is so marked a feature in the human organism it is a reasonable supposition that some kinds of cells are more sensitive than others to the action of toxic substances. Of all the cells of the body those of the nervous system are peculiarly sensitive to conditions external to them. The quantity and character of the blood circulating through the nervous system immediately influence the nature of the metabolism within the nerve cells. Fainting, delirium, convulsions, lassitude are some of the many symptoms of an abnormal action of the blood on the nerve centres. Such sensitiveness to bodily conditions is what we should expect in a system which regulates and controls the activity of all the other systems of the body, diminishing or increasing it according to internal or external conditions.

Since, too, the cells of the cerebral hemispheres are the most highly differentiated and developed of all the cells, these are peculiarly liable to be affected by toxic agents present in them or in the blood stream, and the effects of such agents will immediately be felt in consciousness. Those agents that stimulate metabolic activity will produce a heightened conscious tone; those that diminish such activity will induce a lowered tone. It is well known that many drugs, such as chloroform and ether, have a very marked influence on the nerve cells of the cerebrum, and produce important changes in consciousness without affecting materially the functional activity of the rest of the system. Alcohol, tobacco, or opium, too, has each its stimulating or soporific influence on the nerve cells.

Effects of Toxic Agents on Consciousness.

It can now be conceived how prolonged and vigorous activity in any tissue, whether nerve or muscle, may lead to conditions which render the further continuance of work increasingly difficult, and how these conditions may be reflected in consciousness by sensations of lassitude, tiredness, and fatigue.

Experiments of Professor Mosso.

3. With a view to gaining some data for working out this problem, Professor Mosso, of Turin, performed a series of experiments on living muscle. Taking a muscle with the nerve attached from a newly-killed frog, he stimulated the muscle to periodic contraction by a series of electric shocks passed through the nerve. By means of a short style fastened to the end of the muscle, and marking a moving sheet of smoked glass, each contraction and relaxation was represented on the glass by a curve. The curve marked after the first shock showed that the contraction proceeded rapidly up to its maximum point. Then the muscle

Muscular Fatigue.

began to relax, quickly at first, but afterwards with increasing slowness, until its original position was reached. With each successive shock the contraction proceeded more and more slowly; the extent of the contraction also diminished and the relaxations became more and more prolonged. Finally, after from 1,000 to 1,500 shocks, the limit was reached and the muscle failed to respond.

From this experiment it is clear that from the first beginning of active functioning there is a gradually increasing inability to respond, leading finally to total disability. But the experiment does not establish whether this increasing inability is due to loss of energy or to the toxic effects of the accumulating waste products. To decide this point Professor Mosso washed the blood vessels of the muscle thoroughly in saline solution, so as to remove the waste products, and then subjected the muscle to further experiment. It was found to respond again, though neither so readily nor to so great an extent as at first. Still, it had regained much of its former power. Consequently, it was clear that much, though not all, of the inability to respond was due to the toxic influence of the waste products produced by the contraction of the living substance of the muscular fibres.

Fatigue of the Nerve Centres.

In normal bodily activity, however, muscular action is stimulated and controlled from the nerve centres, and this experiment, so artificial in its character, gave no information as to what effects might be produced on the nerve centres directing the muscles. To throw some light on this point the hand and arm of the experimenter were strapped to a table, so that no group of muscles could be moved but that of the middle finger, to which was attached a weight by means of a string passing over a pulley. The experiment consisted in raising the weight by voluntary

effort at regular intervals; the results being recorded by means of a style attached to the weight marking a moving sheet of smoked glass.

In this case not only muscular energy but also nervous energy in the various nerve centres controlling the muscles was expended. As the experiment proceeded, the height to which the finger could raise the weight began to diminish, and the contraction of the finger became more and more prolonged, until finally the strongest impulse of the will failed to produce any result. Was the fatigue, however, in the muscular tissue or in the nervous centres directing the muscles? To decide this point electric stimulus was resorted to, the shock being applied to the nerve passing down the arm to the fingers. As a result, the muscles that previously had failed to respond to voluntary effort now contracted, showing plainly that the inability to respond was not in the muscular substance but in the motor centres.

Nervous substance, then, is more liable to fatigue than muscular tissue, and we are thus led to conclude that in all cases of fatigue, even from physical exertion, the fatigue is largely of a nervous character.

Fatigue and Exhaustion.

4. These experiments, and others of a similar nature, rough as they are, suggest beyond doubt that the physiological cause of fatigue, particularly in its initial stages, is not so much the exhaustion of tissue energy as the paralysis of tissue activity by the toxic action of the waste products of that activity. These waste products act as a kind of safety valve, causing disablement of the tissues before their store of energy is reduced to a dangerously low point. There can be no doubt, however, that, as functioning is prolonged, the living substance of the cells begins increasingly to feel the effects of the diminution of energy. As vigorous activity continues, fatigue is rapidly followed by exhaustion, the

effects of which are much more serious and lasting than are those of the initial stages of fatigue. This indicates that in exhaustion there has been a drain on vital energy which can only be compensated by the slow building up of new tissue and the storing of new power. In the initial stages of fatigue, however, relief is obtained when the toxic substances have been removed from the system.

The first signs of fatigue, then, must be regarded as a warning that the nervous and muscular tissues have reached the point beyond which further work will make a considerable strain on their vital energy. The system, or some part of it, is functioning beyond the capacity of the body to deal with the results of that functioning by removing waste products and by restoring the energy expended. As has been suggested, the more sensitive higher centres of consciousness first feel the effects of the toxic waste products, and the first signs of strain are given by the feelings of tiredness and lassitude, by the want of brightness and elasticity, a considerable time before the lower centres and the muscles are materially affected. As work continues, the effect on consciousness increases, thought becomes more laboured, voluntary actions are less skilfully performed, the power of making persistent, strenuous, and patient effort decreases, and disinclination to work becomes increasingly intense. The conscious control of thought and of voluntary movement is thus impeded, and finally it ceases, either voluntarily or through incapacity to continue, before the nervous and muscular systems as a whole have become utterly exhausted.

But when initial fatigue is pushed to exhaustion the body increasingly suffers from loss of energy, and recovery then involves the slow building up of new tissue and energy. The further work is carried beyond the point of initial fatigue, the greater is the drain on vital energy, the

more harm is done, and the slower is the recovery. It is, then, more economical of bodily energy to cease work when the first signs of fatigue show themselves, in order to take a brief recuperative rest, than it is to continue work and push fatigue to exhaustion. During a brief rest taken in time the system rapidly recovers, toxic waste products are removed, energy is restored, and work can be begun again with renewed zeal. Regular successive periods for recuperative rest throughout the day will thus defer the time when work should cease altogether. More work can be accomplished with less harm under such a plan than when work is continued without regular intervals for rest. On the latter plan, when fatigue sets in increasing efforts of will to maintain attention and to force work have to be made; and this means a further expenditure of nervous force, which aggravates the evil.

Recovery from Fatigue.

5. As the cause of fatigue is the toxic action of waste products together with the loss of energy in the functioning cells, rest is essential to recovery. Continued activity can only augment the evil. During the whole time of functioning, however, the system, by means of the blood stream, is endeavouring to cope with the bodily conditions. Waste products are being poured into the blood and circulated through the body and so through the excretory system, and nourishment is continuously being supplied to the working organs. Fatigue, however, means that the body cannot remove waste products and supply nourishment rapidly enough to meet the demands, and thus, so to speak, the bodily machinery is thrown out of gear. Time is needed, during which work ceases, for the blood stream to restore the tissues to their former healthy condition by removing the waste products and by offering supplies of nutriment. The blood, however, though relieving the

working tissues of the waste products, is fouling itself, and circulating these toxic agents throughout the whole system. Hence, though the working tissues are the first organs to be fatigued, yet, as the waste products accumulate in the blood, all the tissues begin to feel their evil effects, and fatigue begins to be general. As the nervous tissue is the most sensitive to the action of toxic agents this fatigue is mainly felt in the nerve centres, especially in the higher centres of consciousness, which are the most sensitive of all.

Change of Work.

When fatigue is purely local it is obvious that change of work will rest those tissues that are fatigued. Change from one kind of mental work to another, or from mental to physical labour, will bring distinct relief and produce good results. Regular changes of this kind throughout the day will bring all the nerve centres into action, and yet will give periods of relaxation for each, during which recuperation can take place. Strain and over-pressure—evils so common at the present day—are largely due to badly adjusted burdens, and would be prevented if changes of work were more frequent.

Although recovery from local fatigue is taking place when the nature of the work is altered, yet general fatigue is increasing. The blood stream still continues to gather in the waste products. Hence, as the day goes on, general lassitude and a desire for total rest denote that the nervous system as a whole is feeling the effects of the day's activity. The system is permeated with the waste products of the continued work, the nervous system in particular responds with diminishing vigour and energy, and feelings of lassitude, tiredness, and fatigue colour our consciousness. Total rest, alone, can remove general fatigue, and this rest is given in sleep.

Sleep. Sleep is the rest of consciousness. The whole system, however, is not asleep. Reflex and automatic actions and organic life go on much the same as during waking life. Dreams, sleep walking, and talking indicate that even some cerebral activity is possible. Yet the essential mark of sleep is the cessation of conscious life and of those bodily activities that depend on conscious control. During sleep, then, we must consider that cerebral activity is reduced below that point at which consciousness appears. Hence, whatever reduces the activity of the nerve cells promotes sleep.

Fatigue is almost always one of the factors in the oncoming of sleep. Continued cerebral activity, involving expenditure of cerebral energy and the accumulation of waste products, reduces the power of functioning, and hence promotes the state of sleep. Reduction of circulation through the brain by lessening cerebral activity is also conducive to sleep. Experimental observation has shown that before sleep sets in at nightfall there are considerable modifications in the bodily circulation. The arteries of the brain contract, while those to the skin relax. Hence less blood flows through the brain and more through the skin; a state of things that promotes cerebral inactivity. Hot-water bottles and warm rooms and clothes, therefore, by promoting circulation in the extremities and skin favour sleep. Cold rooms and insufficient bed clothes are unfavourable. After a meal, too, blood is withdrawn from the brain to the digestive organs. An empty stomach frequently causes a restless night, while a heavy meal induces drowsiness and torpor. A horizontal position and the relaxation of all voluntary muscles cause a slow heart beat, and this is favourable to reduced cerebral action.

The cessation of incoming stimuli and the stoppage of thought mean cessation of cerebral functioning. So in

settling ourselves to sleep we cease active thinking and shut as many as possible of the avenues for incoming stimuli. The room is darkened and quiet and we endeavour to think of nothing. In every way we seek to reduce cerebral activity to a minimum. Pain, noise, light, and whatever promotes thought—such as joy, sorrow, remorse, pricks of conscience, hope, fear, excitement of any kind—by promoting cerebral action with the attendant cerebral circulation delay sleep.

Sleep is necessary to health. Continued want of sleep is, indeed, fatal sooner than prolonged want of food, and the brain suffers far more in the former case than in the latter. Loss of sleep results in marked cerebral changes. There is a steady decrease in the power of attention, memory becomes defective, and the control and intensity of voluntary movement are lessened, all indicating a steady decline in cerebral power. We must conceive, then, that during conscious life the expenditure of cerebral energy is greater than its repair, and sleep is needed as a period when elaboration of tissue and energy can proceed more rapidly than its destruction.

The changes in cerebral tissue during the day's work and during sleep are very well summed up by Professor Donaldson in the following passage: "From the beginning of the day the process of running down goes on, all the constant stimuli hasten it, meals retard it, drugs modify it, according to their nature. In general there is a tendency to run down in the middle of the afternoon, with a return to vigour later in the day. On this long rhythm is superposed one by which in the evening the blood supply to the brain diminishes at the accustomed hour of retiring. This change in the blood supply appears to depend on the waste substances produced by the active cells. These accumulate faster than they are removed and render activity more

difficult. At the beginning of sleep these substances are abundant, the stored material in the cells is small, and the cells themselves are shrunken in various ways. Slowly the toxic products of metabolism are removed, and at the end of two or three hours the sleeper is in a state to be readily wakened, though physiological recuperation has just begun. The circulation has become better, the constructive changes in the cells continue, and at the end of the interval the nerve cells are restored, and the body prepared for the next period of work."[1]

Conditions for Healthy Work.

6. From this analysis of the causes of fatigue and recovery from fatigue it is easy to point out those conditions of living that will most readily induce fatigue and those that will best retard its appearance.

The Nourishment of the Body.

Since one element in fatigue, and the most important factor in exhaustion, is the loss of energy in the functioning cells, it is clear that a well-nourished body is a good safeguard against fatigue. It has already been seen that the liver and the muscles store from the blood surplus nutrition which can be drawn upon in times of excessive and long-continued work. The presence of reserve material of this kind, ready at hand to be transferred to the blood and to replenish the energy of the working tissues, is a great help in delaying fatigue and in preventing the exhaustion which follows if work be continued.

Although reserve material of this kind is a great help in times of active prolonged work, yet a well-nourished body is rather one whose nervous and muscular tissues are replete with nervous and muscular energy. The energy of digested food is then present not simply in the form of

[1] *The Growth of the Brain*, p. 322.

reserve nutriment, but actually in the tissues in the form of nervous and muscular power, upon which large demands can be made without harm resulting. Such tissue, moreover, is full of vigorous life, is capable of more intense activity, and can renew itself with greater energy than tissue of a weak, flabby, and debilitated character.

Especially should the nervous system be thus strong, vigorous, and well-nourished, since fatigue is first felt in it. On its activity depend, moreover, the life processes and the harmonious functioning of all the other organs in the body, and on the tone of the higher centres depends the vigour of mental life. A vigorous and well-nourished nervous system is thus essential to health, to vigorous physical labour, and to sustained mental work. It is well known that after serious illness, when the nervous system is completely debilitated, the slightest mental or physical exertion rapidly brings on fatigue, and, if continued, results in a serious relapse due to exhaustion.

The Supply of Oxygen.

The life and activity of the tissues is also dependent on sufficient supplies of oxygen. So, blood rich in the oxygen carrier, haemoglobin, is obviously an aid to vigorous and prolonged activity without fatigue. Anaemic persons soon succumb to fatigue, and easily become exhausted. All the organs of the body experience the evil effects of the poor vital stream. They are always more or less devitalised. They fail more rapidly, and recovery must be slow, since the building up of tissue is dependent on oxygenated blood. There is, under such conditions, a permanent tendency for fatigue to become chronic, as the tissues are always in a state of reduced energy. Blood rich in haemoglobin is, then, an essential condition for vigorous and prolonged mental or physical exertion.

Fresh air is another important factor in postponing

fatigue. The mere breathing of air charged with carbonic acid and organic refuse from the air passages will in itself bring on a physiological state analogous to fatigue. The blood, under such circumstances, can never become thoroughly oxygenated and cleared of carbonic acid, while the noxious organic substances decomposing in a room, superheated and surcharged with moisture, act as poisonous toxic agents on the blood. To such conditions the tissues react by decreasing activity. The languor, lassitude, and headache produced by breathing foul air indicate that the action on the higher nervous centres is very similar to that resulting from the action of the waste products of the tissues. Well ventilated rooms, then, are a necessary element of the school economy, so that the greatest output of work may be obtained without detriment to the body.

The Circulation of the Blood.

The rapidity with which fatigue is produced and is recovered from depends also on the circulation of the blood. The rate at which the tissues replenish their energy both during and after functioning, and at which the waste products are removed from the working tissues to the excretory organs, is determined entirely by the vigour of the circulation. A sluggish flow of blood is conducive to the oncoming of fatigue. Such a circulation is the natural outcome of a sedentary occupation. The heart is less active during rest than during muscular activity. Hence, if life is of a sedentary kind, the heart becomes adapted to the work it is called on to do, and poor circulation becomes the normal condition. The continued poring over books while sitting in desks, for example, leads naturally to weak circulation, the blood stagnating in the larger blood-vessels of the abdomen, whilst the circulation in the extremities becomes feeble. Cold hands and feet are a sign of enfeebled

circulation. Under such conditions the tissues are incapable of offering a strong resistance to the onset of fatigue. Active exercise is essential if we would secure vigorous work at school, for it is only by means of active exercise that a powerful heart can be developed and circulation made vigorous.

Bodily Exercise.

Active physical exercise during some considerable part of the day should, therefore, be part of the daily life of pupils, and if this is not obtained out of school hours, it should be included in the school curriculum. For younger pupils the amount of class-room work demanded at present is certainly too great. Much more of their time should be spent in active physical exercise in the open air. During winter gymnastic exercises and open-air games should be taken in school hours, for by the shortness of the days play after school is much curtailed.

After each lesson there should be at least five minutes vigorous physical activity. Circulation is thereby improved, and the tendency to fatigue lessened. These intervals throughout the day are suitable opportunities for practising drill, breathing exercises, and indulging in recreative singing. During vigorous muscular exercise, however, respiration is increased, and there is a greater amount of carbonic acid expired. The air of the room is thus being more rapidly fouled than during the more sedentary class-room studies. Consequently it is advisable that during such exercises the rooms should be flushed with fresh air from open doors and windows.

It should hardly be necessary to point out that the rapid removal of waste products prevents the oncoming of fatigue, and also aids in recovery from it. The excretory system must, then, be in a healthy condition. It will be seen in the next chapter that muscular exercise, appropriate

in amount and in kind, promotes the healthy activity of the skin and kidneys. Moreover, habits of cleanliness, by keeping open the pores of the skin, maintain it in a healthy condition, and aid the excretion of waste products through this channel.

The Organisation of School Work.

7. Since a large part of the daily life of the child is spent in school in active mental or physical work, the question of fatigue is very important in school economy; particularly as the period of school life is also the period of growth. The aim of the teacher should always be the development of the child both mentally and physically. Hence the organisation of the school pursuits and occupations should be such that the body, as well as the mind, develops its full capacity by means of such life. No school life is satisfactorily organised if the school conditions lead to physical deterioration or require long periods of rest for recuperation. The school life is out of harmony with the natural line of child growth if the whole being, body and soul, is not harmoniously developed. In a later chapter it will be seen that mental or physical work, if performed under proper conditions, improves the system generally, except when carried beyond the point where fatigue ensues. Beyond this point there is a drain on the vital energy of the system, and positive harm results to health and growth. The teacher, then, must aim at obtaining the greatest amount of activity without harm resulting. Each pupil should be regarded as a living machine with a certain amount of energy to be expended on daily work and with definite powers of recuperation. This living machine is to be worked in the most economical manner. The utmost development must be secured by means of vigorous mental and physical work, yet the occupations should be so organised, and should be

performed under such conditions, that no injury is done to the growing system.

Hygienic Surroundings. Hygienic external conditions of work will be the first consideration. Healthy, well ventilated rooms, bright and cheerful in appearance, well lighted and suitably heated, are the first necessity. The school attitudes in sitting, writing, and reading should be such that if they do not directly promote physical development they yet do not lead to positive harm in spinal curvature, contracted chest, enfeebled circulation, and weak eyesight. Indeed, active measures should be taken, by means of exercises to develop the chest and back, to promote circulation and to counteract any evil effects that may accrue from such positions. Change from sitting to standing, from physical rest to active muscular exercise is essential to health and growth. A school life of a markedly sedentary character will lead to physical weakness and a stunted bodily growth.

Changes of Work. In organising the school occupations the most vigorous work should be demanded when the system is most fresh. The first part of the morning is the best time for mental work requiring close attention and concentrated application. After recreation and meals, too, the body is in a condition to withstand fatigue. A complete change in the kind of work from lesson to lesson, so that different nerve centres are brought into action in successive lessons, is the most economical of energy. The risk of fatigue is still further diminished when the occupations become more mechanical and recreative as the day advances.

Intervals for recreation of a spontaneous and physical character bring relief and promote vigour. This recreative play should be energetic but not violent, and should be carried on in the open air. It should promote active

circulation through the whole system and should thoroughly oxygenate the blood. The tissues by that means will be stirred to vigorous life, while the higher centres of thought will be resting. Recuperation of nervous energy is thus going on under the best conditions. After such recreative play the pupils should feel refreshed, bright, and eager for further steady work. The interval for recreation to be of real value should be sufficiently long; at least from fifteen to twenty minutes. Every possible moment should be spent in recreative play. Teachers should organise suitable games for their pupils and encourage all to participate actively in them. Lounging about the playground should not be permitted.

Intervals for Recreation.

Besides the longer intervals for recreation there should be shorter breaks between successive lessons. These breaks of a few minutes should be used for recreative singing, breathing exercises, and drill. In that way both circulation and respiration are promoted, a few minutes' rest is obtained, and the next lesson is begun with increased vigour and energy.

Home Work.

The end of the school session should not find the pupils thoroughly fatigued, for the evening should bring other occupations for body and mind. Home lessons should not make heavy demands either in time or energy. It should be remembered that the pupils need to enter into the home life, and that reading, indoor amusements, and outdoor games should find a place in their lives. Bedtime should find the child healthily tired, but not exhausted. A fagged, exhausted, or excited brain is not conducive to sleep, and sleep is needed to restore the energy of the nervous system.

The bedroom should be spacious, well ventilated, and neither too warm nor too cold. During sleep respiration

is changed, inspirations are longer, the amount of oxygen inhaled is increased, and the amount of carbonic acid removed is diminished. Hence, there should always be sufficient ventilation to provide the oxygen necessary for thorough recuperation and to remove the carbonic acid and heated air which will otherwise accumulate and render proper recovery impossible. Sleeping in a foul, stuffy, ill-ventilated room is followed by heaviness and a sense of fatigue, indicating that the blood and tissues have not been thoroughly cleansed of waste products nor their energies renewed.

Conditions of Healthy Sleep.

Draughts, however, should be avoided, as the skin during sleep is more active in perspiring and therefore more liable to chills than during the day. On the other hand, the room should not be too warm, as warmth tends to increase the action of the skin and leads to enfeeblement of the system by excessive perspiration. Sleep in too hot a room never gives that feeling of freshness and elasticity which follows healthy sleep.

Sleep, moreover, should not be longer than is necessary for thorough recuperation. Sleep means reduced cerebral activity, and activity is necessary for healthy life and growth. Too prolonged sleep may, then, lead to enfeeblement of consciousness; and this explains why those whose sleep is heavy and long are often dull-witted and unintellectual. It must be admitted, however, that some of the ablest men have been long sleepers. But beyond doubt the circulation of the blood and the expiration of carbonic acid are reduced during sleep. Hence the life processes of the tissues are proceeding less vigorously than during waking life. Therefore, to prolong sleep beyond the amount necessary for thorough recuperation of the system is to hinder growth, for it is by exercise and activity that both body and mind develop.

The amount of sleep required depends on the age and the state of health. Dr. Dukes gives the following table of the amount of work and sleep desirable for boys at various ages :—

	Ages.	Hours of Work.	Hours of Sleep.
Nursery	From 0 to ½	0	20
	„ ½ „ 1	0	18
	„ 1 „ 2	0	17
	„ 2 „ 3	0	16
Infant School	From 3 „ 4	0	15
	„ 4 „ 5	0	14
Primary School	From 5 „ 6	1	13½
	„ 6 „ 7	1½	13
	„ 7 „ 8	2	12½
	„ 8 „ 9	2½	12
	„ 9 „ 10	3	11½
	„ 10 „ 12	4	11
	„ 12 „ 14	5	10½
Secondary School and University	From 14 „ 16	6	10
	„ 16 „ 18	7	9½
	„ 18 „ 19	8	9
	„ 19 „ 21	8	8½
	„ 21 „ 23	8	8

It is noticeable in the above table that Dr. Dukes would only require the oldest pupils in a primary school to work five hours a day. There can be no doubt that the younger pupils work far too long a time at mental tasks. The school life as a whole is of too sedentary and too exacting a character. Many of the school occupations for the younger children should be of a recreative character, and a considerable portion of the time should be spent in practical pursuits in the open air. Strenuous mental work

should not exceed the limits proposed by Dr. Dukes, though such work should not make up the whole of school life.

Precautions during Periods of Rapid Growth.

Especially necessary is it to watch most carefully the state of health of the pupils during the periods of rapid growth. The body during these times needs all the good nourishment and fresh air it can procure to build up its growing tissues. Large demands are made by growth on the energy of the system, and to make further large demands by physical or mental work is to burn the candle at both ends. During these periods the system may easily be run down, the nervous system debilitated, the blood become anaemic. Any predisposition to weakness of heart, lungs, digestive system, or nerves will then show itself in an active and malevolent form During these periods of rapid growth the conditions of life should be as favourable as possible to health and growth. The pupils should have good nourishment, fresh air, physical exercise appropriate in amount and in kind, and periods of relaxation and recreative rest. Good sound sleep is essential, and the day's work should be followed by an evening of gentle and recreative employment, in the open air if weather permits. Intellectual work, if performed under proper hygienic conditions, is beneficial, but care should be taken that it is not excessive and that it is not followed by fatigue and exhaustion.

CHAPTER VIII.

EXERCISE AND GROWTH OF THE BODY.

Exercise in relation to Functional Power and Health.

1. [illegible] natural outcome of organs working beyond their power of recuperation and beyond the ability of the system to replenish their energy and remove the waste products of their activity is fatigue, advancing with continued work to exhaustion. The exercise of an organ within these limits, however, produces other effects of an opposite character, effects equally remarkable and general in their consequences on the system as a whole. The exercise of an organ is followed by an increase in its functional capacity. Exercise, in some way, stimulates the cells of the organ to develop the power of doing their own special work.

Local Effects of Exercise.

A man who accustoms himself to regular vigorous mental labour finds his powers of concentration and application growing. He can as time goes on put forth more prolonged and more vigorous efforts without suffering from fatigue. Similar results follow from muscular exercise. Daily work with the arms, back, and legs results in the whole apparatus of movement becoming larger and stronger. The muscular fibres grow harder and firmer and become capable of stronger contractions and more prolonged activity. The joints become easier and freer, the tendons stouter and tougher, and the bones larger and denser. The whole

mechanism of movement becomes by exercise more effective for vigorous work and for resisting fatigue.

Continued inactivity on the other hand reduces effectiveness. Mental idleness renders the cerebral centres incapable of strenuous and persistent work for any length of time. Attention quickly flags and fatigue readily sets in —proofs that nervous vitality in these centres is diminished. The effects of muscular inactivity are equally obvious. The muscles become soft and flabby, the joints stiff; movements are executed with less intensity, effectiveness, and grace; active exercise is soon followed by fatigue. Total disuse of any organ, indeed, leads to an increasing loss of functional power. Inactivity begets degeneration.

General Effects of Exercise.

Just as fatigue has its effects on the whole system, so exercise not only influences the functional power of an organ, but also modifies the life processes of the whole organism. The general effects on the system as a whole are more immediately apparent in the case of muscular exercise than in that of nervous activity, because the muscles form by far the largest proportion of the body both by weight and by volume. Any tissue changes taking place in such a large mass cannot but have a marked influence on the life and functional activity of every other organ in the body.

The general effects of muscular exercise are most readily realised by contrasting one who lives a sedentary life with one living an active physical life. In the case of the former there is a general tendency to poor physique, though the actual result in the case of individuals is not the same. People differ in their power of adapting themselves to physical conditions. The tendency to poor physique is, however, the normal result of a sedentary life. The blood tends to become poor in quality and fouled with impurities, and this state of the blood is reflected in the impaired

vitality of all the tissues. The beat of the heart becomes feeble and irregular, the chest flat, the appetite poor, the muscular frame soft and flabby, the kidneys and liver weak and irregular in their action. Vigorous exercise quickly induces breathlessness, perspiration, and palpitation, and prolonged work brings on fatigue. Mental life, too, is affected. Headache, languor, irritability, want of control, and diminished power of strenuous and persistent intellectual labour show that the nervous system is as reduced in vitality as is the muscular. Recuperation after fatigue or exhaustion becomes increasingly slow. Both nerve cells and muscular fibres seem to have less vitality. Their life processes go on less vigorously, and this shows itself in a lowered tone in nerve and muscle, and in a feebler power of recuperation. Continued physical inactivity, evidently, results in disorders as general and as marked as those that follow exhausting work.

In almost every particular the physique of the man engaged in active physical labour differs from this. The blood is richer and purer, the heart stronger and less liable to irregular action, the chest broader and deeper, the appetite keener, kidney and liver troubles less frequent, the muscular frame larger and firmer, and continued physical work is carried on with greater power of endurance. Recuperative power after illness, fatigue, or exhaustion is more vigorous, and this shows that vitality of the cells of the tissues is more intense and that the living substance of nerve and muscle has greater powers of reconstruction and elaboration.

A life of considerable physical activity seems, then, essential to good physical vitality. One would be led to expect this from a consideration of the body as a living machine made up of parts functioning in relation to each other. The life of the body as a whole must be suited to

its structure, and the large proportion of muscle it contains would seem to indicate that that life should be, in a large measure, a physical one. Within limits, it is true, the body has the power of adapting itself to changing circumstances. A reduction in the amount of physical exercise and an increase in mental labour can, within due limits, be endured without disorder of a serious or permanent nature ensuing. The system, however, seems incapable of adapting itself to a life of almost total physical inactivity. The mass of muscle, under such circumstances, hangs on the system like a drag, and the physical disorders that follow its inactivity emphasise its demand for exercise. Every organ responds up to a certain point to the needs of the system as a whole, and the heart, lungs, digestive and excretory systems are adapted to supply the needs of a nervous and muscular system capable of doing certain work. If the demands made by either the nervous or the muscular system be excessively large or unduly small, the whole machine is thrown out of gear. The muscular system may, by excessive work, make demands on heart, lungs, and excretory organs greater than they can adapt themselves to, and breathlessness, fatigued and strained heart, or general fatigue and exhaustion follow. On the other hand, by inactivity the response of the heart, lungs, and excretory system may be so reduced that the activity of these organs is not sufficient to serve the rest of the system, and disorders ensue.

The Effect of Exercise on Nutritive Changes.

2. The effects of exercise on functional activity and on health generally are entirely due to altered nutrition. Exercise not only increases the nutritive changes going on between living substance and the blood, but it alters their nature, so that tissue of a different character is elaborated during activity from that constructed during

rest. Any organ that is in functional activity stimulates the nerve centre of organic life in such a way that the arteries supplying the organ with blood relax, the heart beat is increased, and respiration becomes more frequent and deeper; the amount of such response of course depending on the extent of the activity. Consequently, during activity an organ is supplied with blood in greater quantities and more oxygenated than when it is at rest. The increased circulation, too, persists for some time after activity ceases, so that recuperation can more thoroughly take place.[1]

Effect on the Nutrition of Working Tissues.

The increased flow of highly oxygenated blood to the working tissues during and after activity necessarily results in more active nutritive changes. Tissue elaboration proceeds more rapidly. What is of greater importance, however, is that it is of a different character from that which obtains when the organ is at rest. During rest there is a tendency for the cells of the tissues to transform the nutriment of the blood into by-products of the nature of reserve foods such as glycogen and fats.[1] It is well known, for example, how an inactive life tends to the accumulation of fats in and about all the organs. The cells when not regularly performing their own special function, revert to the general type of cell that merely feeds and stores food, but does not elaborate that special form of living substance necessary for the performance of a special function.

When actively functioning, however, the cells build up the material used in supplying the energy for their special form of activity. Muscle fibres elaborate real contractile muscular substance, and nerve cells real

[1] *Vide* Chapter VI., § 7. [2] *Vide* Chapter VI., § 5.

excitatory nervous substance. The cells are stimulated to this special form of metabolism by their own activity. Hence, active functioning leads to the increase of functional power.

It can now be seen how a change from disuse to regular activity of an organ is followed by very marked changes in that organ. During disuse the cells degenerate, their special functional vitality is reduced, they are more prone to fatigue, and have a diminished power of recuperation. Degeneration, for example, is commonly observed when a man after a life of intellectual labour retires to spend his remaining years in peaceful rest. Before long nervous degeneration frequently sets in, and is followed by disorders such as paralysis and softening of the brain. When a change is made from inactive to active life the reserve substances are used up, but they are not lost. They are transformed into real muscular and nervous substance. The cells gain in functional power, they are capable of more strenuous and prolonged activity, and have an increased power of recuperation. The functional power of an organ, then, can only be maintained and developed by the continued exercise of that organ.

General Effect on the Organic System.

The effects of exercise on the system generally are similarly due to more active nutritive changes of a general character consequent on increased circulation and respiration. Since both heart and lungs are stimulated by exercise, the circulation through the whole system is more vigorous and the blood more oxygenated. Hence the nutritive changes throughout the whole of the tissues—nerves, muscles, and glands—proceed more intensely during exercise than during rest. Life throughout the whole system is lived at a more rapid rate. There is a greater general demand for nutrition. Reserve materials are

freely drawn on, and the appetite is improved, and this simply means that the system is ready and willing to absorb more nutrition. In spite of the reduction of reserve substances the weight of the body is increased, because the body as a whole is living a more vigorous nutritive life. Every organ thus benefits, and the vitality of the whole system is improved.

Besides the increase in nutritive changes there is a greater activity in the excretory organs. The increased circulation through skin, kidneys, and lungs improves the excretory activity of these organs. Moreover, through the organic centre, exercise stimulates the action of these organs. But just as exercise results in an altered nutrition, so it changes the character of the waste products formed. The cells during activity are living not only a more rapid life but a changed life, and this is seen in the formation of different waste products as well as in the elaboration of a different kind of tissue. Fats and glycogen contain an extremely large proportion of hydrogen and carbon, and, when reduced, form carbonic acid and water with a great evolution of heat. These products are removed by the lungs and skin. Hence a man leading a sedentary life, with a strong tendency to the accumulation of waste products, finds that vigorous exercise soon affects his breathing, makes him perspire, and renders him uncomfortably warm. One living an active physical life, however, keeps reserve substances at a minimum, and the life processes of the cells being different in character, breathlessness, fatigue, and uncomfortable perspiring do not so readily appear.

The total result of the improved action of the skin, lungs, and kidneys is to purify the blood. All the tissues, and especially the nervous tissues, feel the beneficial results. Mental life becomes brighter and more elastic. Languor

and lassitude disappear. Fatigue is more easily resisted, and both body and mind are invigorated.

Exercise and Fatigue.

3. A sedentary life, then, means that, through the relative inactivity of circulation, respiration, digestion, and excretion, the life processes of the whole system proceed at a lower pitch. Indolence, physical or mental, begets the seeds of disease. Exercise stimulates these organic processes, and so long as the heart, lungs, digestive and excretory organs can meet the demands of a vigorously active system, the whole system benefits by the increased life. The body lives the best and healthiest life and develops most during the time of growth if brain and muscle are exercised to the limit which their powers can bear, and at which the system as a whole responds to their organic demands. For full development the need of unrelenting activity of every power presses upon us from the cradle onward.

But if this activity be too great or too long continued temporary injury results, and if the strain be still further prolonged this becomes permanent. Fatigue and exhaustion indicate that work is carried beyond the point at which work benefits the body. Tissues exhausted of their energy need to be built up again, and may never thoroughly recover their lost vitality and power of recuperation. There always remains a tendency to break down more readily under strain in the future. Fatigue is only temporary; rest, fresh air, and nutrition speedily remove it. Exhaustion tends to become a permanent injury.

Breathlessness is one sign that physical activity is being carried beyond the limits of safety. In breathlessness heart and lungs are being excited to the limit of their capacity in bringing air and blood together in the lungs. When breathlessness sets in rest should be taken or serious injury may result.

Growth Measured by Increase of Weight and Stature.

4. In active physical life a greater quantity of food and oxygen is capable of being absorbed into the system and built into the tissues than in a sedentary life. Hence, besides an increase in functional capacity and organic vitality, an active life brings an increase in weight. Increase in weight may be taken as a rough measure of the vitality of the organism. Growth, however, though promoted by nutrition and exercise, is an innate power of the organism during a period of life, a power that differs in individuals. Some people are destined by nature to be tall and well built; others to be of small stature and weight. Yet it is well to know the average rate of growth in order that variations from it may be explained by reference either to innate capacity or to conditions of life.

Since increase in weight and in stature is in some degree a rough measure of the vitality of the system it may be taken as a criterion of health during the growing period. But stature is primarily dependent on a lengthening of the bony structure, and after all only gives one dimension, while the body is increasing in three. Increase of weight, then, furnishes the best indication of development.

Growth, as measured by stature and weight, proceeds rapidly from birth to the age of twenty-five and continues but very slightly to thirty-five or even forty. It is not, however, regular from year to year, or from month to month. Variation even occurs from day to night. Statistics show that from August to December is the period of greatest increase of weight, though this may be explained as coming after a period of active outdoor life in summer and autumn. Sunshine, too, has beneficial effects on vitality. Stature, on the other hand, is increased most rapidly from the middle of April to the middle of August. A similar divergence is noticed when increases of weight

and stature during the day and night are compared. "The various and careful observations of Camerer show that a child of ten years is 700 grammes lighter and 2 cms. taller in the morning after a night's rest, and during the day it is losing in stature and gaining in weight."[1] Food, sunshine and activity promote vitality; repose in a position in which the body presses most lightly on the growing tissues seems to be the condition most favourable to increase in stature.

Normal Increase in Weight and Stature.

The most important irregularities in increase both of stature and of weight are those that obtain at certain times in periods of growth from birth to twenty-five. The accompanying diagram (Fig. 9), constructed from statistics obtained by Roberts from observations on the general population of Great Britain, shows the average or normal rate of increase in stature and weight for both sexes from birth to the age of twenty-five.

"Glancing at the curve for males it is seen that for the first year of life increase in weight is rapid. This is followed by a period of slower increase up to seven years of age. From here the weight increases again more rapidly up to sixteen years, with a maximum rate between sixteen and seventeen years. The rate then falls to twenty-five years, and from that time on, if the curve were continued up to fifty years, the increase would be slight although continuous."[2]

The curves for females are very similar to those for males, though showing less absolute gain on the whole than in the case of males. Especially is this similarity marked up to the age of about ten or eleven. Then, after a period of considerable divergence, the curves finally show

[1] Donaldson, *The Growth of the Brain*, p. 83.

[2] *Ibid.*, p. 52.

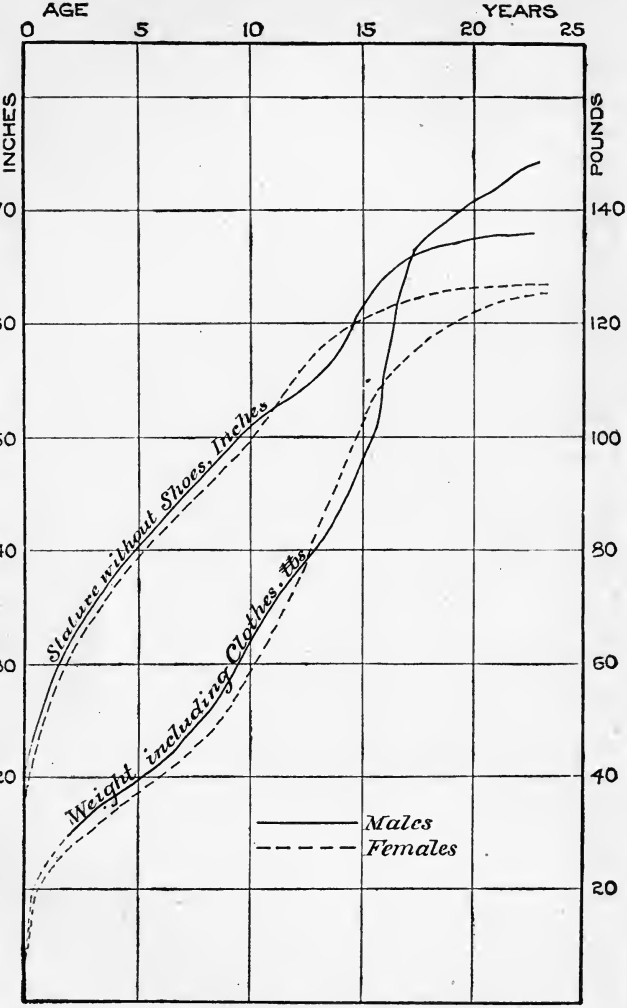

Fig. 9.—Height and Weight Curves. Donaldson—*The Growth of the Brain.* (Scott.)

the female at maturity some twenty-five pounds behind the male in weight and some four inches less in stature. At about the age of eleven the girl begins rapidly to increase in stature and then in weight, while the boy still maintains the same steady increase that prevailed from the end of the first year. At about the age of twelve the girl outstrips the boy and continues her rapid increase until about sixteen years of age. From twelve until sixteen, indeed, the average girl is both heavier and slightly taller than the average boy of the same age. After sixteen comes for girls a period of steady though greatly diminished increase until maturity is reached. The period of rapid increase for boys does not begin until a year or two later than that for girls. When, however, the period does arrive the increase is both greater and longer continued, and although from twelve to sixteen years of age girls are generally heavier and taller than boys, yet at sixteen, so rapidly are the boys gaining, the girls are outstripped, and the boys gain the foremost place, and they continue to improve their position onward to maturity.

Conditions of Life affecting Growth.

Growth is a sign of organic vitality, and the power of growth is innate. It may, however, be hindered or promoted by the conditions of life. The conditions of life then will show their traces in the weight and stature of the growing child. Food, fresh air, and appropriate exercise with periods of rest promote health and growth; under these conditions the weight and stature of the child should attain their fullest capacity. On the other hand, chronic conditions of fatigue and exhaustion, food poor in quality or small in quantity, foul air, poor blood, weak digestion, all hinder growth. The natural capacity for growth under these conditions receives a check, and the body never attains

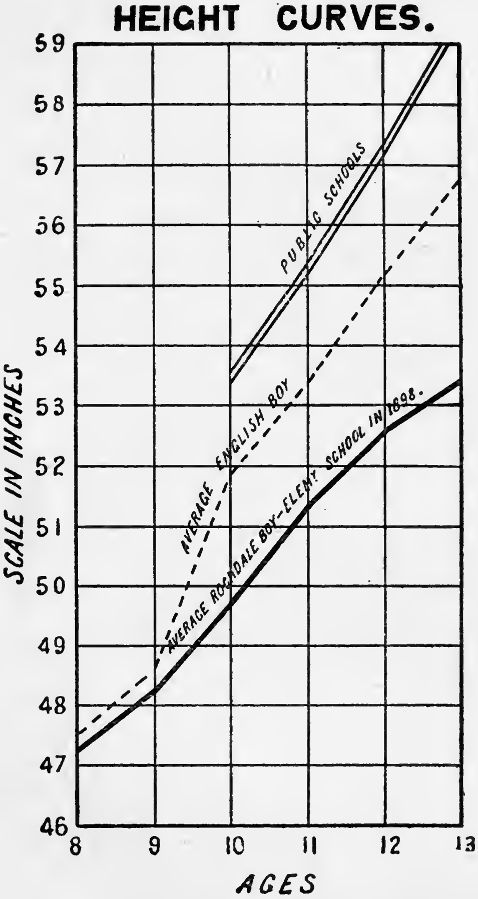

Fig. 10.—Height Curves. Mark—*Educational Theories in England.* (Sonnenschein.)

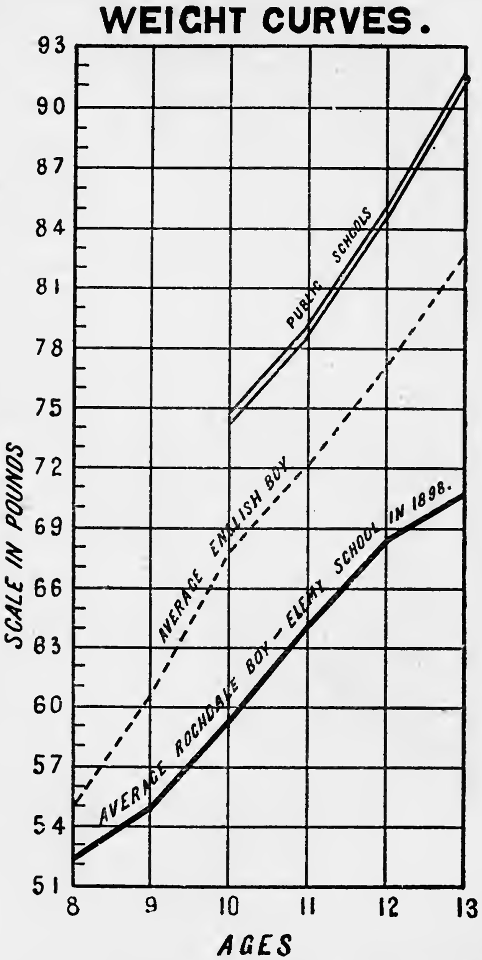

Fig. 10 A.—Weight Curves. Mark—*Educational Theories in England.* (Sonnenschein.)

the standard of perfection marked out for it by its innate constitution and power of growth.

Careful observations on growing children confirm the above principle. During serious illness increase of stature ceases, whilst weight actually diminishes,[1] though these may be more than counterbalanced by the rapid increases during convalescence. The underfed or badly fed children of our sunless and foul-aired slums are as a class small in stature and below the average weight for the country. On the other hand, the public school boy, who is well nourished and whose life includes plenty of exercise in the fresh air, is above the average stature and weight for the country, and far beyond those of the average youth of our factory towns of the North (see Figs. 10 and 10A).

The period of rapid growth, from twelve to sixteen for girls, and from fourteen to eighteen for boys, is a time when great care is needed. At this time of life boys and girls have a tendency to outgrow their strength, a state of fatigue may easily become chronic, and any tendency to weakness of heart, lungs, nerves, and digestive organs may easily become accentuated and serious mischief result. Physical exercise or mental work during this period should never be so great as to strain the system. Gentle exercise should be freely taken, and with fresh air and good nourishment this period of stress will be passed without mischief resulting.

Measurement of Weight and Stature.

Seeing how important weight and stature are as indications of healthy growth it is important that parents, teachers, and school doctors should periodically measure their children in these respects. The weight and stature of each child should be taken on entering school and with strict

[1] See Donaldson, *The Growth of the Brain*, Fig. 11, p. 57.

regularity every six months after. Increase of weight, though absolutely less or greater in any particular case, should in the main follow the curve of increase for healthy boyhood and girlhood. Any marked or sudden stoppage or diminution of increase is a sign that something is interfering with the general nutrition of the system. These effects may be the results of insufficient food or of malnutrition. Improper food, bad teeth, or disordered digestion as well as insufficient food may cause a falling off of weight. Overwork, either physical or mental, insufficient sleep, want of exercise, or positive weakness or disease may also result in a falling off of weight or stature.

Equally important signs of vitality are the general demeanour and the attitude in walking, standing, and sitting. Vitality shows itself in a bright, happy, and energetic mental and physical life. Energetic life is the normal condition of the healthy child. Disinclination to do anything vigorously, moping, irritability of temper, unhealthy colour, want of appetite, stooping when walking, bending forward in sitting are symptoms of weakness.

Physical Training and Health.

5. Since the effects of physical exercise on the system as a whole depend on the stimulus it gives to the action of the heart, lungs, and skin, the amount of benefit resulting will be proportional to the increase in activity of these organs, provided that the exercise does not result in too great fatigue either general or local. Speaking generally, the heart, lungs, and skin are stimulated in proportion to the rate at which energy is expended. The more quickly bodily energy is expended the more rapidly is tissue broken down, and the more are the centres of organic life in the bulb driven to excite the heart, lungs,

and skin to increased action. It follows then that, if physical exercise is to produce its most beneficial effects on health and functional capacity, it must be sufficiently vigorous and prolonged to influence appreciably the action of the heart, lungs, and skin, though it should not be of such a nature as either to exhaust the tissues engaged in movement, or to fatigue the heart by compelling it to do more work than its strength can bear.

Exercises that develop the System generally.

Groups of large muscles can, of course, do more work, and do it more easily and rapidly, than groups of small muscles. When the large muscles of the legs, thighs, and body are doing active work the effect on the system generally is much more pronounced than when only small muscles, like those of the hand or arm, are used. Climbing a hill, running upstairs, wrestling, playing football, running races, quickly induce breathlessness and perspiration, simply because energy is being rapidly expended in doing work. But, as many large muscles are in action, the work is done easily and without fatigue to the muscular and nervous tissues engaged in it. On the other hand, the muscles of the hand or arm, work they never so vigorously, are fatigued long before respiration and circulation are sensibly affected. The smaller the group of muscles brought into play the more violently and strenuously must they work to produce the same general effect as many and large muscles working easily and steadily. It follows then, that such games as football, hockey, and fives, exercises such as running, rapid walking, swimming, and skipping, contests such as wrestling, are more beneficial to general health and vigour if judiciously pursued than those that employ few muscles.

Exercises that strengthen the Heart.

The heart and the lungs, being stimulated to increased activity, share in the benefits obtained from exercise. Not only do they share in the general increase of vigour, but they are strengthened in their functional power by the increased work they are called on to do.

The muscles of the heart become larger, firmer, capable of stronger contractions and more resistant to fatigue, and they gain increased power of recuperation. Benefit to the heart will result from exercise so long as the increased activity does not lead to heart fatigue or exhaustion. Long continued or violent physical exertion may strain the heart, and permanent weakness of that organ may follow. Fatigue of the heart, gradually approximating to exhaustion, is always a possible risk in vigorous and prolonged physical exercise, especially if such exercise be taken without preparatory training, or in sudden violent spurts. A holiday spent in mountain climbing, after a year's sedentary life, finds the heart little prepared to withstand the strain involved in climbing steep slopes. The heart quickly falls into a state of chronic fatigue and requires very prolonged rest for its recovery. Before violent exercise, like football and running and wrestling, is indulged in, the heart should be gradually strengthened by regular exercise increasing in amount and vigour.

Certain exercises are peculiarly apt to place a very considerable strain on the heart and larger arteries. Sudden violent movements, like many of those in wrestling or in lifting weights, require a firm and rigid body, in order that the arms may be used to the utmost advantage. The necessary rigidity of the bodily frame is obtained by filling the lungs with air and forcibly holding the breath. This action places the heart and great blood-vessels in the chest under considerable pressure. The heart has not only

to force the blood against the normal pressure of the system, but also against the added pressure of the lungs on the large arteries and veins. This tendency to stop circulation impels the heart by reflex action to violent efforts to restore it, and strain and weakening may result. That a violent and physical effort of this kind does seriously affect circulation is evident from the swollen veins in the face and neck that accompany such exertion, the flow of blood from the head into the great veins of the chest being checked. During physical exercise, then, it is well that breathing should proceed freely, naturally, and as regularly as possible. Bursts of extreme violence should be avoided and holding the breath discouraged. Breathlessness should be a warning that rest is needed.

It is necessary, too, to emphasise the importance of rest in developing a strong heart action. Activity, followed by rest, is the golden rule of development. But the heart must always be active. It can never secure complete repose. Relative rest only is possible through the diminished beating that obtains during sleep and when the body is in a resting position. Resting the body, by sitting or lying down, rests the heart, and gives it a chance to recuperate its strength. Persons whose hearts are weak should never indulge in violent exercise. Moderate exercise, with many opportunities for rest, however, is good for them, as it will gradually strengthen the heart, and render it more capable of bearing the strain of an active life.

Exercises that develop the Chest.

Chest capacity is an important factor in healthy life, and is especially necessary to vigorous and prolonged physical activity.[1] A football player plays and a runner runs with his lungs and his heart as much as with his legs and body. If a man has good chest capacity and a strong

[1] See Chapter VI., p. 8.

and sound heart he is capable of greater and more prolonged exertion than if his lungs are small and his heart is feeble.

The lungs may, by appropriate exercise, be made larger and more capable of performing their function of gaseous exchange. In ordinary breathing the whole of the air cells of the lungs are not used, and even those used are not expanded to their fullest extent. Full expansion of all the air cells only occurs during extraordinary breathing, when the lungs are filled to their utmost capacity by the full action of the diaphragm and the muscles of the chest and shoulders. It is, then, by the encouragement of extraordinary breathing that the capacity of the chest will be enlarged. When all the air cells are expanded to their fullest extent the walls of the chest are thrust out with greatly increased pressure. Occasional deep breathing, however, can effect little. The muscular and bony elements in the chest walls will only gradually adapt themselves to stresses and strains if the pressure be regularly and constantly applied. The most opportune time for developing chest capacity is when the body is growing. The muscles and bones are then growing and are more pliable, and the chest capacity under such conditions can be rapidly improved by appropriate means to the great benefit of health and growth.

Deep Breathing Exercises.

Since breathing is, to some extent, under the control of the will, direct means can be adopted to develop chest capacity by deep breathing exercises. The exercises should aim at expanding the lower part of the chest where the cross-section is the greatest. Hence, the exercises should mainly bring into play the diaphragm and the muscles of the lower ribs. Shoulder breathing, which expands the narrow upper part of the chest, should be discouraged.

Besides aiding the expansion of the chest, breathing exercises should also induce the habit of correct breathing through the nose, so that the breath will be warmed and the air purified in its passage through the nasal channels. Breathing through the mouth is apt to cause serious throat and lung troubles. Frequently, mouth breathing is due to growths, called adenoids, in the nasal passage at the back of the throat. Sufferers from adenoids may easily be recognised by the undeveloped nose and the open mouth, which give the face a somewhat vacant expression, and by deafness, which frequently accompanies adenoids. A very simple operation is necessary to remove them.

Exercises that promote Control of the Breath.

Formal breathing exercises, however, are very artificial in character, and should quickly advance to exercises in which the pupils are taught how to control the expenditure of breath in such occupations as singing, reciting, walking, running, jumping, and climbing. In all these occupations, and especially in singing and running, the lungs require to be filled to their utmost capacity and the expiration of air controlled in such a way that words can be uttered sweetly, softly, and steadily in the case of singing, and that breathlessness is not induced in the case of running. Singing, indeed, is a great aid to the growth of the chest, as are all occupations that require the lungs to be filled to their utmost capacity. Thus, instead of taking formal breathing exercises at odd moments during the day, it is a more interesting and valuable occupation to arrive at the same result by means of voice-training exercises, which, while expanding the chest, are at the same time training the voice. The same principle should hold in the physical exercises in the school yard or gymnasium. Deep breathing should always be combined with walking or running exercises, so that breathing is

not practised *in vacuo*, but in connexion with some definite occupation.

Exercises for training a Correct Attitude in Breathing.

The attitude of the body in standing, sitting, walking, and running is an important element in effective breathing. The body should be held in such a way as to free the action of the chest and give the diaphragm and ribs full play. Stooping attitudes, with the shoulders bent forward and the abdomen pressing on the diaphragm, hinder the downward movement of the diaphragm and the upward and outward movement of the chest and walls. Hence, exercises for developing an upright carriage in sitting, standing, walking, and running are of great importance. Such exercises should strengthen the muscles of the back and shoulders by movements that involve an upright carriage, or that bend the body backwards and bring the shoulders as far back as possible. Raising and lowering the body on the toes with the hands on the hips and the elbows forced back, arm exercises that force the arms slowly behind the back, and other exercises of a similar character are good for this purpose. Continued stooping and sitting in desks tend to make habitual those attitudes that hinder free breathing. Especially, then, is it necessary to insist on erect attitudes in writing and sitting, and to counteract the tendency to round shoulders and slouching induced by work in desks by games and exercises that will develop the lungs, straighten the figure, and hold the shoulders in a proper position.

Games that develop the Chest.

Chest capacity, however, can be increased by means less formal and artificial than these. Any physical work that involves a considerable expenditure of energy in a short time affects breathing. The more violent the exercise the more the lungs are stimulated to deep breathing.

Hence, running, jumping, rapid walking, skipping, wrestling, football, fives, hill-climbing, and any other exercise the vigorous performance of which is likely to induce breathlessness will develop chest capacity if regularly and actively pursued. Mere arm exercises, on the other hand, are not so beneficial, since, as the muscles of the arm are small, they must work very violently indeed before breathing is affected. Such exercises, however, do strengthen the shoulder muscles, and when they are of the right kind they tend to develop an upright carriage.

In the more violent games and exercises, such as running, football, and walking, breathing shows a tendency to get out of control. The breathing is apt to become shallow and rapid instead of deep and slow. The pupils should be shown how to take in breath and how to control its expiration when engaged in violent exercise like running. Inspiration should be deep, full, and slow, and expiration should let the air escape gradually. Panting should, if possible, be prevented.

Chest Measurement.

In watching the physical development of the pupils it is of great importance to observe the growth of the chest. Opportunities should be taken when the pupils are stripped for swimming and bathing, or during and after physical exercises, to examine the shape and size of their chests. When the chest is poor in shape and capacity, special exercises should be given. Regular chest measurements should be taken, so that not only is the physical development of the pupils tested by the increase in weight and stature, but also by the increase in their power of deep breathing.

6. Up to the present we have had mainly before us the physiological aspect of exercise. Physical exercise,

however, is not merely a matter of physiological importance. Almost any form of exercise, if pursued sufficiently vigorously and regularly, will promote health and strength, and, if these qualities alone constituted the end in view, then the system of physical training that was founded on a thorough knowledge of the structure of the body, the functions of the various organs, and the conditions of their development would be the best. Such a system would be suited to every type of character and to every nationality, for only physiological, and not mental, grounds need be considered. Physical education, however, aims not only at a physical but at a mental result. Besides training health and strength, it seeks to train skill and those aspects of intelligence and character that are necessary to the effective performance of the practical activities of life.[1] Mere health and strength we seek in our beasts of burden; skill in our acrobats and gymnasts; but the essentially human qualities required in the practical activities of life are intelligence, courage, hardihood, resolution, the personal virtues of self-reliance, self-confidence, and self-respect, and those qualities needed in free, willing, and earnest co-operation and competition with one's fellows.

Educative Value of Physical Pursuits.

In any comprehensive system of physical training, then, there must be found:

Training in Health, Strength, Skill, Intelligence, and Character.

(1) Factors that make for health and strength.

(2) Factors that make for skill.

(3) Factors requiring the continuous play of intelligence.

(4) Factors of danger and hardship.

(5) Personal and social factors, by which the strength,

[1] See Chapter II., § 5.

skill, intelligence, and spirit of a pupil or body of pupils are pitted in friendly, though earnest, rivalry against the strength, skill, intelligence, and spirit of another pupil or body of pupils.

Pursuits should be based on the Natural Impulses of the Young.

A true system, moreover, should be founded on the natural impulses of youth, and appeal to many sides of human nature—the practical, individual, social, and aesthetic. The best practical pursuits for school are those that approach most nearly in character, and so lead naturally into, the occupations, recreative or otherwise, of real life. Such occupations have the most meaning, and appeal to the young as being of real value, just because they are based on so many fundamental impulses of human nature. They are not artificial and peculiar to school life, invented and bolstered up by the ingenuity of one who regards life as made up of separate and independent compartments, and is blind to the evils that must follow if life, either in school or in the world at large, is viewed piecemeal instead of as a whole.

Practical pursuits that appeal to many spontaneous impulses of the young are just those that will maintain their interest and value throughout a great part of life, though of course they should advance in form as the skill and interests of the youth develop. Interests and habits once formed by such school pursuits can continue, out of school and after school days are over, to influence the development of the youth physically, intellectually, socially, and aesthetically. Indeed, it may truly be said that a school exercise is valuable in its bearing on life's activities just according to the number and the importance of the aspects of human nature to which it appeals. An exercise that trains strength and skill is of greater value and has a stronger hold on life than one that merely trains strength.

One that further appeals to intelligence, aesthetic taste, or the competitive and co-operative spirit has still further value. Such an exercise is anchored by many chains to the life of the boy and girl, and will continue to hold its place and influence the life of the man and woman long after artificially devised forms of activity have ceased to interest. The practical pursuits of school, then, should do more than merely amuse or furnish exercise. They should be of such a character as to be capable of developing into forms of skill and interests which are of value in after life. But it must be remembered that the recreative side of future life has claims to be considered as well as the utilitarian, and a comprehensive education will secure that the recreation of the man and woman benefits the body and mind.

Systems of Physical Training.

7. Several systems of physical training have grown up in various countries, but for purposes of discussion they can all be brought under one or other of the three main types represented by Swedish drill, German gymnastics, and English games.

Swedish Drill.

Swedish drill consists largely of exercises of the arms, body, and legs without apparatus. The pupils are usually drilled in large classes, and the movements are performed at the word of command. The exercises are so devised as to develop the muscular frame, improve the health, and assist physical development generally. Considerable ingenuity has been exercised in their invention, and their advocates claim that they are based on a thorough knowledge of anatomy and physiology. That they are ingenious, methodical, and systematic everyone who knows them must admit. These qualities, indeed, are apt to carry away the mind and to induce an admiration and enthusiasm for them that render one blind

to those qualities that should be present in every comprehensive scheme of physical training, but are absent from Swedish drill. Method, indeed, so far vitiates the whole course of exercises and the procedure on which they are conducted, that practically nothing is left to the initiative and originality of the pupils.

German gymnastics generally consist of exercises that are performed with apparatus in a gymnasium. They include exercises on horizontal and parallel bars and vaulting horse, exercises with Indian clubs and dumb-bells, and such contests as fencing and wrestling. Some of these are performed individually; others by the pupils in classes at the word of command.

German Gymnastics.

English games hardly need description. They mostly involve running, catching, and struggling movements. Some are played with a ball, some without. Some need implements and a special ground, others can be played in any open space. Unlike Swedish drill and German gymnastics, they are not the invention of educationists, but have grown up through the ages as the common, every-day play of the boys and youths of the country. Physiological principles, therefore, have not determined their construction, although physiological principles are not thereby broken in their pursuit. We may gain health and strength from games, although we do not play them for that purpose and they were not invented with that object. They appeal mainly to the love of movement, of strife and struggle, of emulation and rivalry, of competition and co-operation, of boyish fun and high spirits that are so eminently characteristic of the youth of all ages.

English Games.

If the principles of physical training that have here been insisted on be applied to a comparative examination

of the exercises, games, and contests of the three systems, very marked and fundamental differences in the educational value of the three systems are revealed. The exercises of Swedish drill mainly develop health and strength, though certain elements of skill also enter into them. They cultivate the power of quick, smooth, and easy movement at the word of command. It is obvious, however, that they fail to cultivate initiative. The will of the pupil is not freely and willingly exercised either for personal or for social ends. It is under authority, passively submissive or unwillingly dominated. Into these exercises also enter no continuous play of intelligence and no individual or social strife demanding courage, endurance, self-denial, self-reliance, and determination. Intelligence and character in the conduct of the practical affairs of life can in no wise be trained by exercises so mechanical and monotonous in their nature.

Games, Contests, and Exercises Compared.

In German gymnastics with apparatus, courage, hardihood, and skill are certainly trained, while into the contests of wrestling and fencing, intelligence and spirit enter. Fencing and wrestling are thus clearly of greater educative value than exercises on the horizontal and parallel bars. In the latter, once the skill, the 'knack,' is acquired, the feat can be performed almost automatically, and tricks on the bars differ only in degree from the more simple exercises with dumb-bells and wands. In fencing and wrestling, on the other hand, two intelligences and characters are opposed to each other. Automatic skill and strength, though factors in the issue, are by themselves useless. They are but instruments of which intelligence and character have to make use. Each mind has constantly to be on the alert, watchful and observant, and coolness, presence of mind and quickness of judgment, determination and

self-control often defeat mere strength and automatic skill.

Higher still in the educational scale come social games such as football, cricket, hockey, etc. It will be interesting to examine for a moment the winter pastime of football—the Rugby game—since for educational purposes, with boys at any rate, the Rugby game is distinctly superior to the Association. As the game is played in the open air and in the damp and cold of winter, the body is hardened to inclemencies of the weather. All parts of the body are exercised in the various movements of running, scrummaging, tackling, kicking, and throwing, and considerable skill is demanded in many of these actions. During the game there is a need for continual alertness, keen observation of the state of the game, insight into the tactics of the opponents; and a cool head, ready wit, and quick decision are great factors in success. Courage, hardihood, and resolution are brought into play in tackling and scrummaging, while self-control, self-denial, free, active, and unselfish co-operation, a sense of responsibility and of honour and sportsmanship are encouraged.

Physical Training for Schools.

8. It is evident, then, if school life is to cultivate those aspects of intelligence and character that are necessary in the effective performance of the practical work of life, that games and contests, both of an individual and of a social character, should form the main element in the course of physical training. They should, of course, be suited to the strength and skill of the pupils, but they should also develop that strength and skill along broad and generous lines. The games and contests must be so combined as to develop the whole body and to train skill in many kinds of movements. The little ones should play simple children's games with simple

Games and Contests.

dancing movements accompanied by singing, such as maypole dancing, imitative action songs and recitations, and games like 'ring-a-ring of roses.' With children from seven to ten years of age running, catching, jumping, hopping, and skipping games are valuable. Ball games, too, should form part of a course. They develop strength in the arms and train skill in throwing with accuracy. In all ball games the teacher or instructor should emphasise the throwing element. In the upper classes of the school these simpler pastimes should advance to games and contests of a sterner and more vigorous character, such as wrestling, boxing, fencing, quoits, football, hockey, fives, cricket, and running, jumping and leaping games such as leapfrog.

The pupils should receive instruction in the elements of the game in order that the utmost benefit in skill and in strength may be obtained from the practice. A game regarded as part of the school life is more than mere amusement. Though it gives enjoyment and pleasure and appeals to many natural impulses, it should be pursued strenuously and with a desire to attain as much proficiency as possible. Fortunately it is not difficult to get boys to take games seriously. They are only too eager to play games and to desire to excel in them. It is, indeed, no uncommon thing for them to take their sports and games too seriously.

As an example of the kind of instruction that should be given, let us consider an afternoon spent on the cricket field. The first part of the time should be spent in practice under the direct instruction of the teacher. All the pupils should take part in throwing, catching, and stopping the ball. First there might be practised throwing at the wickets from long and short distances, an exercise requiring strength, skill, and judgment. Next, catching a skied

ball or a hot return, and stopping balls coming quickly along the ground or half-volleys could be practised, either hand or both hands being used. Such practice will encourage alertness, agility, and steadiness. Then should come practice at the wickets. Several pitches and many balls should be in use, and all the pupils should take their turn in batting, bowling, and fielding. The instructor should give directions how to stand and play the ball, and how to bowl and field. Practice finished, a game among the pupils is organised. Captains are chosen and the instructor takes his place as a spectator who may give advice and counsel when asked, or who may even give directions when occasion demands. The instructor should see that the captains take their full share of responsibility in directing the game, placing the field, and in encouraging and stimulating their teams to do their best.

Physical Exercises.

Though games should form the main element in physical training, yet there is need for exercises of a more formal character.[1] These should be of a preparatory nature, to give instruction and practice in the movements required in the games and in life. The exercises should give practice in walking, running, jumping, leaping, and climbing. These are best performed in the school yard or in the gymnasium, where also such contests as boxing, wrestling, fencing, and tug-of-war can be taught and practised.

Running and walking are too often performed with awkwardness of gait and with a slouching carriage. In walking the body should be poised firmly but freely on the hips, so as to be capable of free and easy movement. The body should not 'wobble' to and fro, nor the shoulders move up and down in time with the movements of the legs. The head should be held erect to give freedom to

[1] See Chapter II., § 2; Chapter V., § 4.

breathing, the chest out, the abdomen in, the shoulders square to the front and drawn back. The arms should swing easily by the side, with the elbows to the rear. The movement in walking should be from the haunch, and should be free, easy, and springy. The knee should be braced back when the foot is supporting the body, but should bend easily when the leg is moved from rear to front. To secure an elastic and springy movement the various joints in the foot, ankle, knee, and hip should be used freely and easily. No part of the body should be held stiffly.

In running, the same principles should be exemplified. The body should be inclined forward, but the head, chest, abdomen, and shoulders should be in the same relative positions as in walking. The arms should be raised, the fists be clenched and should move backward and forward with freedom. The pupils should spring lightly and easily from the toes, with the joints in the foot, ankle, knee, and hips working quite freely. The feet should be well raised from the ground.

Walking and running exercises should form a part of every physical training lesson, and similar instruction and practice should be given in jumping, leaping, and climbing. The exercises should also include some designed to cultivate grace and ease in attitude and movement. These will be largely slow movements of the arms, body, and legs in bending and balancing. They should be performed to music, and the pupils themselves should sing. Agility and alertness will be developed by means of exercises quickly and rapidly performed. Lunging movements are suitable in this form of exercise.

9. There is little doubt that the kind of school life seen in our modern primary and municipal secondary schools is too largely of an indoor character. Practical

pursuits, especially those that can be taken in the open air, do not form a sufficient part of the school occupations. If school life is to aim at giving a practical training in health, strength, skill, and those qualities of intelligence and character required in practical life, then the arrangements of school work need to undergo considerable modification. Some form of outdoor physical exercises should occupy a part of every school day, even if the school day for the older pupils has to be lengthened for that purpose. All authorities agree that the present class-room day for the younger pupils is too long.

Organisation of School Life for Games and Exercises.

Country excursions should be organised in connexion with nature study, physical geography, and history.[1] These excursions should develop such intellectual and aesthetic interests in country life as will lead the pupils to use the country as a means for intellectual and physical recreations in their leisure time and after school days are over. Several such excursions should take place each year. During a class excursion brisk running and walking should be indulged in, and the afternoon might well end in half an hour spent in running, jumping, and wrestling contests, or in some vigorous ball game.

Country Excursions

Holiday times, too, might be made of more use than they are at present. In too many cases holidays are merely intervals for loafing, lounging, and general idleness, which will only lead to moral, physical, and mental degeneration. Holiday camps for the older pupils are a valuable means for turning holidays to an educational use in training physique, character, and country tastes. A spot should be chosen for the

Holiday Camps.

[1] See Welton, *Principles of Teaching*, Chap. XI., § 4; Chap. XII., § 5.

camp that gives free scope for nature study and geographical excursions and for roaming, climbing, and swimming. Good plain food and hard work should be the rule. Part of the day should be spent in outdoor instruction in land surveying, carpentry, drawing, painting, nature study, and physical geography. Most of these involve excursions and constant roaming and rambling. Another part of the day should be given over to games and contests. During a third part of the day the pupils should be left to their own devices to engage in whatever outdoor pursuit takes their fancy. Such a régime during a holiday could hardly fail to benefit the pupils of our crowded towns both in physique and in character.

Playing-fields and Playgrounds.

If games are to form a real part of the school life playing-fields are desirable. Wise education authorities would endeavour to provide each school with opportunities for using some open space during some days of each week. In the country access to fields should not be difficult. In the towns recreation grounds should be used as fully as possible. Most schools have at least playgrounds, though in few cases are these used to the best advantage. The playground should be in constant use for games or physical exercises. There should always be some class using the playground, and care should be taken that undue noise is not made. Part of the playground should be under cover and, if there is no school gymnasium, there should be provided in the playground mats for jumping and wrestling, hurdles and stands for jumping, ladders for climbing, and ropes for tug of war. Blank walls in the playground should be used for some form of fives.

Every game and exercise should be carried on strenuously and vigorously. No exercise has its full benefit on the body unless it appreciably affects breathing and circulation.

Hence, though breathlessness should be regarded as a warning to rest, the exercises and games should tend towards breathlessness and free perspiring.

Dress and Dressing-rooms.

Cleanliness demands that special clothing should be used during the exercise and that bathing the whole body should follow it. Many parents, of course, would prefer to provide the special dress themselves. Where parents cannot, or do not, provide it the school should lend a dress in the same way as it lends books and writing material. Boys should wear a simple shirt and knickerbockers. Waistcoat, coat, and braces are out of place when free and agile movements are wanted. A similar dress with skirt added should be worn by girls. After the games and exercises the pupils should pass to the dressing-rooms, where they should strip and wash. Hot and cold water sponge baths should be supplied if shower baths cannot be obtained. Brisk and smart rubbing with a coarse towel should follow.

Physical Training after School Life.

10. Though much can be done by including games, contests, physical exercises, and other practical pursuits in the life of the school, yet the period of life after school is equally important in training physique and character. Unfortunately, too many pupils leave school at an age before very much permanent good can be done in establishing interests, habits, and moral stamina. The ex-pupils are left from the age of about fourteen to manhood to drift as their inclinations may lead, without any attempt to encourage and stimulate them to continue to develop the interests and habits formed during school life. Lounging, loafing, and feebleness of character are thereby, if not encouraged, at least not discouraged. It seems not only desirable but necessary to establish some system whereby the ex-pupil can continue after school life to reap the

benefits to health and character that come from the practice of games. Clubs for ex-pupils should be established in connexion with each school, and teachers should show great interest in them and give every encouragement to them. School patriotism will by such means be greatly strengthened and a more powerful tradition maintained than at present pervades primary schools. Continuation schools should have a strong sports side organised, and this would tend to make them more popular institutions than they often are at present. The various religious bodies would do well to strengthen the games and sports side of their social clubs for young men. The authorities in charge of the public affairs of our large towns should provide recreation grounds, which can be placed at the disposal of all clubs of ex-pupils, of the pupils of continuation schools, and of the members of religious bodies. These grounds could be used during the week days by the pupils of the day schools. It is in such ways as these, by encouraging educational and social activity, that youths from fourteen years onward may be retained under organised discipline, greatly to the benefit of the national physique and character.

CHAPTER IX.

CLEANLINESS.

The Excretions from the Skin.

1. The skin is an important excretory organ for the removal of waste products. It has been computed, though with how much accuracy it is difficult to say, that a greater quantity of matter leaves the body through the skin than by way of the lungs. However that may be, the amount of waste matter exuded through the pores of the skin during the course of the day is very considerable, and the foulness and odoriferous nature of a badly ventilated living room are perhaps due as much to the activity of the skin as to that of the lungs. Some idea of the importance of the skin as an excretory organ may be formed when it is realised that the average number of sweat glands per square inch is over two thousand, and in some parts, as for example the palm of the hand, reaches three thousand.

Sebum.

Besides the sweat glands there are in the skin other glands that secrete an oily waxy fluid called *sebum*. These sebaceous glands are found in connexion with the hairs of the skin, for which the oily sebum serves as a natural pomade, besides keeping the skin soft and moist. The hairs of the skin are set in long narrow pits or follicles, which project downward from the surface to the under skin, from the blood-vessels in which they obtain their nourishment for growth. Into the neck of the hair follicle the sebaceous glands pour the oily

fluid, which exudes slowly to the surface of the skin through the mouth of the follicle.

The sebaceous glands are fairly constant in their action, but the activity of the sweat glands varies with the condition of the atmosphere and the state of the body. During warm weather perspiration is increased and during cold weather it is decreased. Active exercise and mental excitement are among the numerous bodily conditions that increase the amount of sweat given off.

Sweat.

The sebum is an oily fluid. The sweat, on the other hand, is mostly water, which under normal circumstances evaporates immediately into the air or is absorbed by the fibrous substance of the clothing. About two per cent. of the sweat, however, consists of inorganic salts and organic substances of which sodium chloride and fatty acids are the chief. The peculiar smell of sweat is due to the volatile fatty acids and to the oily sebum. It is largely to the diffusion of these substances through the air of a room that the foul odour of a badly ventilated living room, of a dormitory in the morning, or of a class-room containing many children, is due, though, as has been seen, the organic substances passed into the air by the breath contribute their share.

Effect of Excretions on the Atmosphere.

The presence of these organic substances in the air of a room is highly detrimental to health. They form an excellent breeding ground for the germs of disease, which, stimulated by the warmth and moisture of breathed air, live and multiply rapidly on the organic refuse of the body diffused through the air or deposited on the walls and clothing of the inhabitants. Thus, badly ventilated and infrequently washed class-rooms are admirable forcing-houses for the propagation of disease microbes, and there is no doubt that the rapid spread

among children of such infectious diseases as measles and scarlet fever is due to large numbers of children being brought together in confined spaces favourable to the rapid multiplication of germs. Especially is the spread of tuberculosis favoured by these conditions. The air of a room foul with organic refuse and containing the germs of the disease is breathed over and over again by the pupils, and the weakly and badly nourished fall victims. Since prevention is better than cure the remedy is to be sought in cleanliness—cleanliness of the air, of the room, and of the bodies of the pupils. The first, being a problem of considerable magnitude, is perhaps better considered in a chapter dealing with ventilation. The cleanliness of the person and of the room is now to be discussed.

Cleanliness of Rooms.

2. The walls of a room should be constructed of a material that will not facilitate the deposit of dirt or the absorption of organic substances diffused through the air of the room. The surface of the wall should, moreover, be washable, though this quality is not a virtue if only passively contemplated. Papered or whitewashed walls are, therefore, undesirable. Smooth glazed tiles, polished cement, paint or varnish, and washable distempers form good hygienic surfaces for the walls. It is, however, advisable to wainscot the room to the height of about six feet with varnished wood. All rooms require thorough and regular cleaning and washing. Disinfectant soap or fluid should be used and the rooms thrown open to the air. Fresh air and sunlight are excellent purifiers.

Cleanliness of Clothing.

3. Remembering that excretion from the skin is constant, we must look upon the body as being wrapped in an invisible mantle of heated air, saturated or almost saturated with moisture, and permeated with volatile organic substances.

There, thus, seem to be some valid grounds for the firm belief of the ancient Greeks that it is good to expose the skin to the free action of sun and air. It is certainly essential to the healthy action of the skin, and consequently to the general health of the body, that the perspiration should be freely carried away. The necessity for clothing, however, does not render this entirely possible.

One function of the skin is to secure a uniform and constant bodily temperature of about 98° F. Heat is being constantly produced by the decomposition of tissue, and the body is kept at a uniform temperature by the loss of heat from the skin. It must be remembered, however, that all the heat lost has to be produced by tissue combustion. If, therefore, owing to low atmospheric temperature the loss of heat is great, there must be a corresponding increase in the production of heat by greater tissue decomposition, which will necessitate larger quantities of food, especially of heat-producing foods. Within limits, it is true, the loss of heat can be regulated by the reflex relaxation and contraction of the blood-vessels of the skin. Yet in climates such as that of England the balance of income and loss of heat during the varying seasons of the year must be maintained partly by modifications in food and exercise, and partly by regulation of the amount of clothing to meet the variations of the atmospheric temperature.

The clothing, then, should be of such a nature and so worn as to allow perspiration to escape as freely as possible, and yet such as not to chill the body. Tight clothing and many wraps are not good for health. During summer, and especially during vigorous exercise when perspiration is freely produced, clothing should be loosely worn. There is much to be said for the wearing at these times of a simple woollen shirt and loose trousers that give fairly free

play to the air and yet do not permit of too rapid a loss of heat from the skin. The substance of the clothing should be permeable to air, absorb moisture without becoming wet, not retain organic substances, and yet be a bad conductor of heat. Woollen clothing best satisfies these conditions. Cotton and linen material are conductors of heat, less permeable to air, and are quickly wetted by the perspiration, and so chill the body. The underclothing worn during the day should be exposed to the air at night to purify it, and the night clothes should for similar reasons be thoroughly aired during the day, especially as the skin is more active at night than during the daytime. Underclothing, too, should be frequently changed, since moisture, inorganic salts, and organic impurities tend to accumulate in the fibres of the substance.

Cleanliness of the Skin.

4. Although the moisture and some of the fatty acids are carried away by the air or absorbed by the clothing, yet much of the dissolved substance of the sweat and the oily fats of the sebum are left behind on the skin. This residue, oily in character, softens the superficial scales of the outer skin which are ready to be cast off, and the whole forms what might well be termed the natural dirt of the skin.

Necessity for Cleanliness.

It is very desirable that the dirt of the skin be frequently and regularly removed, as it is not only a danger to the health of the individual himself, but also to that of others who are compelled to be in his society. If allowed to accumulate on the skin, the dirt would quickly block the pores of the sweat glands and, by interfering with their activity, harm the general health of the body. There can be no doubt that the skin of an unclean person fails to perform its function of cleansing the blood; the lungs and kidneys are then constrained to endeavour to do its work together with

their own. Good health, bright cheerful spirits, unclouded intellect, and power of self-control, as has already been shown, depend largely on the purity of the blood stream which nourishes the cells of the brain. Unless, therefore, all the excretory organs thoroughly carry out their part in the bodily economy, the imperfectly cleansed blood exercises a paralysing effect on the life processes of all the tissues, and impairs the vigorous activity of mind and body.

The constant accumulation of organic substances on the skin, moreover, affects the atmosphere of living rooms. Organic substances, especially when warmth and moisture are present, tend to decompose, and nauseous vapours are diffused into the air. Unclean skins mean foul putrid air to breathe. It has been pointed out as one of the most pleasant results of the regular bathing of children in some of the German schools that the air of the class-rooms at once became purer and sweeter. Lastly, the organic substances left on the skin form excellent feeding grounds for vermin and for the propagation of disease germs. Most of the skin diseases prevalent among children of a certain social class are due solely to uncleanliness.

Washing and Bathing.

Cleanliness, then, is essential to health and to vigorous work, and frequent and regular washing is not only desirable but a duty to oneself and to others. Being oily in character the dirt of the skin is not easily removed by pure cold water. The most suitable solvent is a combination of hot water and soap. The soap forms with the oily substances an emulsion which is rapidly washed away by the hot water. Brisk, quick rubbing with a rough towel then removes any of the residue and scales which are softened by the hot water, and completes the thorough cleansing of the skin. Friction with a towel, moreover, by increasing the blood supply to the skin, promotes the activity of the sweat glands.

The whole of the skin should be cleansed daily, and the parts exposed to the dirt of the air more frequently. The most effective bath for cleansing purposes is the warm or hot bath, the water in the former being from 95° to 98° F., and in the latter from 98° to 105° F. Bathing in water at these temperatures, however, causes a greatly increased flow of blood to the skin. Hence, after a warm or hot bath there is considerable danger of catching a chill. It is advisable, therefore, to take warm baths before retiring at night or to follow them by a rapid sponging of the body with cold water and brisk friction with a rough towel.

If the morning bath is preferred—and there is much to be said for starting the day clean, refreshed, and invigorated by a bath and a brisk rub down—the cold or tepid bath is most suitable. Though not so efficacious for cleansing purposes as the warm bath, yet the cold or tepid bath acts as a stimulant to the skin, that is, if immersion is followed by the warm glow due to the rapid return of the blood to the skin. If an after glow is not obtained the temperature of the water should be raised, and under no circumstances should the body be chilled by a stay of more than a few seconds in the cold water. It is claimed that the cold bath, by rendering the blood-vessels of the skin more responsive to changes of temperature, diminishes the tendency to catch chills.

Education in Cleanliness.

5. It will hardly have needed the foregoing discussion to have convinced educated Englishmen that bodily cleanliness is a most desirable virtue. Its inculcation, however, is largely a matter of home customs and home conveniences. All houses should have baths with hot and cold water. But though you can lead a horse to the well you cannot make it drink, and the presence of baths in houses may be no assurance of their daily use. In training young children

to a cleanly life lectures and formal instruction in hygiene are of small value, especially if set against home customs and ingrained habits. The clean Englishman is clean not because he knows the scientific reasons for cleanliness, but he keeps himself clean from self-respect and a punctilious abhorrence of dirt and because he takes a delight in the invigorating and refreshing 'feel' of a clean body. Habits of washing and bathing practised for years become as natural to him as his habits at meals. To create such an attitude to cleanliness, to inculcate a hygienic conscience, to awaken a repugnance to an unclean body, and to train habits of daily washing and bathing should be one aim of physical education.

This aim can only be attained by training the conduct of the child and developing his moral and aesthetic feelings. There is no harm in instruction in cleanliness. But by itself it is useless, a waste of time which would be more wisely spent in the practice of cleanliness. It will do good if there is a basis of feeling and habit to be strengthened, for then it will give reasons for feelings and habits that are there. But it is the end of training, not the beginning, the coping stone of the structure, not the foundation stone. Two thousand years ago Plato laid it down as a principle that the child should be trained, not at first to a knowledge, but to a love, of the beautiful and good, and to a hatred of the ugly and bad, so that he "will approve all that is beautiful, and enjoying it and absorbing it into his soul will grow up in the strength of it and become a good and noble man; whereas all that is ugly he will censure and loathe in his very youth, *before he is able to apprehend a principle; but when the principle comes before him, he who is thus nurtured, above all others, will welcome it with the recognition due to that which is his own.*"[1]

[1] Plato, *Republic*, Book III., 401e-402a (italics mine).

This principle is as applicable to the English child of to-day as to the youth of Ancient Greece. If education authorities and teachers are really desirous of inculcating cleanly habits, a pride in cleanliness, and an abhorrence of dirt, they must give up all hope of salvation through mere instruction, and anchor their faith on training the pupils by means of a cleanly life.

Training in Cleanliness in School.

6. It may seem out of place for the school to undertake this duty, but there is every reason why it should. The pupils spend a considerable part of the day at school, and the uncleanly habits of any portion of the scholars are a danger and an unpleasantness to the rest. When children are compelled to attend school it becomes the manifest duty of the authorities to see that the school is not a hot-bed of disease and a foul noisome chamber to self-respecting teachers and scholars. Bathing and washing at school, too, become all the more necessary if physical exercises, drill, gymnastics, or games form any effective part of the school pursuits. To be of use, these exercises must stimulate the circulation, respiration, and perspiration. The effects, obvious to the eye at the end of a gymnastic lesson, should be increased breathing, heightened colour of the skin, and perspiration. Cleanliness demands that the exercises be followed by a thorough wash and brisk rubbing with a towel.

Necessity for School Training.

The school, if it undertakes the work of training in cleanliness, must, then, endeavour to inculcate habits and arouse moral and aesthetic feelings. This is all the more necessary in those neighbourhoods where home influences are likely to be antagonistic to this end. The whole efforts of the staff and the arrangements of the school must aim at creating a proper 'tone' on the subject of cleanliness.

Tone is the key to the whole problem, and its dominant note must be pride in the cleanliness of the person and the surroundings, and a scrupulous, almost quixotic, abhorrence of anything approaching uncleanliness. The more the home circumstances set a bad example, the more nice and particular must be the school attitude on this question. Unfortunately the facilities for home bathing are not universal. Many of the houses in villages and in the slums of our large towns have no bathing accommodation. Provision for bathing at school in these places thus becomes imperative. The school must make up for the deficiencies of the home.

Example and Environment.

Necessarily the first care of the teachers must be their own example. Teachers cannot be too particular in this respect. Their appearance and habits should pointedly show their repugnance of dirt. Then every effort must be made to keep the school itself scrupulously clean. Walls, floors, windows, desks, books, everything should point the obvious moral. In their attitude to the cleanliness of pupils, teachers should show the most particular discrimination. A dirty child should not mix with his companions. Dirty hands, face, boots, and untidy, unbrushed clothes, should call forth immediate and certain disapproval. Every offender against cleanliness should remove himself instantly and cleanse himself before taking his place as a member of the school society.

School Tone.

Much, however, depends on the attitude adopted by the teacher in carrying out these measures. The offence is not mainly against the teacher or his authority, but against the school society. To disapprove of uncleanness, or to punish it by an appeal to personal authority, is to place the teacher above the school and the school society. "Clean children in a clean

school" should be the pride of the pupils, a part of the school reputation; uncleanness an offence against the school honour, and the pupils should care for the honour and reputation of the school equally with the teacher. The attitude of the teacher to an offender should imply that he is unfit to mix with his fellows until he has cleansed himself, and that he has had no care for the honour of the school. The teacher, too, should exercise the utmost tact and judgment in securing the approval of the class in the measures he takes. He should endeavour to create and strengthen a school conscience that will instinctively disapprove of uncleanness. If, then, the teacher acts throughout by appealing to his own authority, if he does not voice the opinion of the class or school, if he has not behind him the public and private assent of the body of pupils, if he does not base his judgment on pride in the reputation and honour of the school, then he may dominate the offender, but his influence in creating a public conscience on the subject of cleanliness will be but little and is too likely to be actually a negative quantity.

A formal inspection of the pupils is not to be recommended. Such is not the most effective way to gain their tacit approval. But constant watching of a less formal character is very necessary, and those unclean in person or clothes should be sent away to cleanse themselves. For a first offence a private talking to is advisable. The teacher should lay the motto of the school before the pupil, appeal to his pride in its reputation, and to his self-respect, and encourage him to show exemplary scrupulousness in endeavouring to be worthy of his school. In cases of frequent uncleanness the parent should be asked to come and see the head teacher. Gently and persuasively, for it is a delicate subject, the head teacher should point out that

her child is the black sheep of the flock whose habits are meeting with the disapproval of his school fellows. The virtues of cleanliness and tidiness should be hinted at and the mother advised to supervise personally his daily ablutions and to make her child a respectable member of the school.

Lavatories. For the carrying out of remedial measures washing accommodation, hot water, soap, and towels should be amply provided. The soap should be carbolic disinfectant, and the towels should be removed when wet. There should be a towel for each child, an ideal which is realised in the best Continental and American schools. The washing accommodation should be sufficient

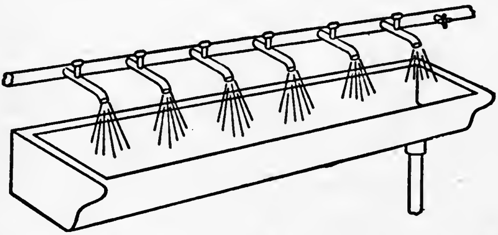

Fig. 11.—Diagram of Washing Trough for Pupils to Wash in the Spray.

for many of the pupils to wash themselves after play. A large number of pupils after recreation are sure to have dirty hands, and they should be trained to proceed at once to wash themselves before beginning class-room work. Slackness in these matters cannot but be fatal to the formation of an active hygienic conscience. It is most important that pupils do not wash in water that has already been used, or use towels someone else has used, for in that way skin diseases and ophthalmia rapidly spread. Several kinds of wash-hand-basins have been designed to secure this end.

Perhaps the most satisfactory arrangement is one by which the pupils wash in the spray from the tap. An illustration of the Doulton Improved Trough Lavatory in use in the schools of the London County Council is given.

Washing in the lavatories should be under the careful supervision of a member of the staff, who should see that pupils thoroughly cleanse themselves, use clean water, and their own towels.

Shower Baths.

The washing of the whole body is, however, as important as the keeping clean of the hands and face, though it is more often neglected. If the school undertakes a crusade against uncleanness, the whole and not a superficial part of the problem of cleanly habits should be grappled with. The difficulties

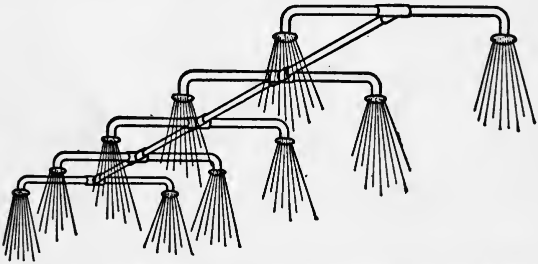

Fig. 12.—Diagram of Spray Bath for Bathing a Large Number of Children.

raised with respect to school bathing are largely those of expense, yet the outlay in providing baths and bathing rooms is not really large, and it would meet with its due rewards in brighter and healthier pupils, in purer and sweeter air in the class-rooms, and in improved work.

The most convenient arrangement for bathing large numbers of children is by means of a system of hot and cold showers. The children should first be well lathered

with soap. Each child then needs only to be under the shower for a few minutes to rub himself briskly all over. The shower should be warm to begin with, but become progressively cooler. The bath should be followed by brisk friction with a coarse towel. With a system of from ten to twenty showers a class of forty pupils can be undressed, washed, dried, and dressed in a few minutes. School bathing of this kind is now practised with great success in many schools in America and on the Continent, and the example set might well be copied by a country that prides itself on its cleanly ways. An illustration of a system of showers is given above.

One of the most appropriate and opportune times for school bathing is immediately after gymnastic exercises and school games. Indeed these exercises demand a bath to follow. Exercise when of value promotes a vigorous activity of the skin, and the resultant perspiration should be removed immediately. The pupils should be trained in the custom of regarding bathing after active exercise as 'the proper thing.' There is little doubt that once the pupils experience its stimulating and refreshing effects the practice will recommend itself to them in a way far more effective than will talking about the invigorating consequences of a bath.

Swimming.

During the summer months swimming should be one of the weekly exercises, and it should be thoroughly taught. The exercise is not only cleanly and healthy, but is admirable for training all the muscles of the body and developing the lungs. Young pupils first need to become accustomed to being in the water. Afterwards they require to be shown how the body is kept afloat by the downward pressure of the hands and arms and driven forward by the backward thrust of the feet and legs. Instruction in this can very well

take place in the gymnasium, but its application requires the swimming bath. Where a pupil is timid, or has difficulty in the harmonious action of arms and legs, he should have swimming practice in the swimming belt.

Closets and Urinals.

It is advisable here to say a few words about the construction, management, and use of the school closets and urinals. So often have ill-health and virulent disease in children been traced to the unsanitary construction or negligent management of these buildings that the head teacher's duty of inspecting and supervising their use and cleansing should be the one duty he should most conscientiously and thoroughly perform. The head teacher has the high duty of seeing that every school officer—class teacher, caretaker, or cleaner—does his work efficiently. He is responsible for any neglect. On him should fall the blame if disaster results from his negligent oversight or failure of power to direct thoroughly and forcefully the work of his subordinates.

English primary schools are usually supplied with an insufficiency of sanitary conveniences. The minimum of wash basins, closets, and urinals recommended by the Board of Education is a number based on principles of economy rather than on those of the science of health. A closet for every sixty in a school of three hundred boys does not err on the side of sanitary convenience. It would be wiser in these matters where children's lives and health are at stake to take the advice not of architects or economists, but of officers of health. The latter may be trusted in this age of hygienic enthusiasm not to err on the side of danger, economy, or architectural design.

In the construction and management every device that ingenuity can suggest should be used to attain the end of thorough cleanliness, and cleanliness here means cleanliness of the air inside the closets and urinals and cleanliness of

the walls, floors, partitions, receptacles, pedestals, and of all surfaces exposed to the air. Much in the structure may hinder or facilitate cleanliness. The air should blow freely through every part of the urinals and closets, which should be in a position exposed to the sun and wind. Nothing purifies so well as strong sunlight and currents of fresh air. Above and below all doors should be spaces for the free passage of air. The partitions between the closets should not extend to the roof. Six feet of height is sufficient for privacy, and will leave a large space below the roof for the free passage of air from end to end. Let there now be large ventilating spaces in the end walls and roof and the whole length of the buildings and each separate closet will have the benefit of copious draughts of air. Urinals should be uncovered open to the air. But why multiply details? The object of all these suggestions is to secure that no space or corner shall harbour stagnant air and that the structure shall be such that whichever way the wind blows it will find inlets and outlets to encourage through draughts of air from end to end of the whole interior.

The same thoroughness of detail should be applied to maintaining the most perfect cleanliness of all interior surfaces. These should be of the plainest description, smooth, polished, and non-absorbent. Projections and corners should be avoided. They harbour dirt and invite negligent cleaning. Where corners must be, let them be rounded off. The floors should be of such a hard, smooth material and so sloped that they can be swilled with copious supplies of water and mopped dry. The buildings should be fitted with a hose-pipe for the quick and thorough daily cleansing of the walls, floors, partitions, and pedestals of the closets and urinals.

The drainage of the closets and urinals is of the utmost

importance in maintaining the cleanliness of the buildings. Separate closets, each with a separate pedestal, drain trap, and flushing cistern, are cleaner than the long trough on to which open several seats, the whole trough being flushed by one cistern acting automatically at intervals and shut off from the main drain by one trap. The latter form is frequently used on account of its cheapness, and it is fairly satisfactory if properly attended to. It is capable, however, of getting into the most disgusting condition if neglected. In matters pertaining to the health of children it is better where possible to eliminate the human factor, for *humanum est errare*. For the same reason all flushing arrangements should act automatically. The urinals should be made of glazed earthenware, have a water trough, and a continuous flow of water over the surface as well as an automatic flush.

In many country districts a large water supply cannot be obtained. In these places the earth closet should be substituted for the water closet. Earth, loose and moderately dry, is an excellent absorbent and deodoriser, and when mixed with faecal matter in a short time it, or rather the multitude of micro-organisms in it, so acts on the substance as to render it not only absolutely innocuous but, owing to the formation of nitrates, a fair manure for agricultural purposes. The earth closet makes use of this action and provides a discharge of earth in the place of water. The earth closet should be intelligently designed for the keeping of earth, for its automatic discharge and for the thorough cleansing of the whole of the interior. It requires the constant supervision of the head teacher and the personal daily attention of the caretaker to remove the pails, to keep the receptacles full of earth and the automatic action in order, to provide a stock of suitable earth, and to cleanse all exposed surfaces.

The regular and thorough cleansing of the closets and

urinal is a most urgent duty and one that is too often neglected. Let the head teacher clearly realise that he is morally responsible for any illness, disease, or death that result from filthy outbuildings. It is his business to inspect their condition, supervise their cleansing, and report to the authorities any faulty structure. If he would have his conscience free from blame, let him be most clear in his directions to the caretaker, most exacting in his demands for cleanliness, most fastidious in his standard of cleanliness, and most punctilious in his daily inspection.

Instruction in Cleanliness: in the Primary School.

7. It has been our endeavour throughout to lay the main stress on the formation of cleanly habits, on arousing and strengthening a hygienic conscience, and on inculcating feelings of self-respect and pride in connexion with personal habits. These aspects must be the foundation of the training. After this is well laid, instruction finds a place in giving the pupils an intelligent understanding of conduct that has become second nature. Instruction in cleanliness has, however, not only a hygienic but a moral aspect, for to be clean is a duty to oneself and to others. Both aspects of the instruction lose their value if given in any formal and merely theoretical way. What is taught should arise out of, and bear directly on, the practice of the school and the moral and aesthetic attitude of the school tone. The value of the instruction, indeed, depends on its incidental and practical character.

For example, the most appropriate time for considering with children the subject of cleanliness would be after some flagrant case of uncleanness which has called for public censure. A few weighty and direct words to the assembled school, pointing out the high duty of cleanliness and the simple hygienic reasons for it, should touch the feelings of the school and rouse a public abhorrence

to uncleanness of person. These occasional "lectures," added to a high school tone and habits of cleanliness, will do more to creating a hygienic conscience than many lessons on scientific hygiene.

in the Continuation School.

The educator of well-balanced mind, however, will always have before him the fact that the discipline and influence of the primary school cease to affect its pupils, directly at any rate, at the early age of fourteen, or even earlier. During the years from fourteen to manhood, important as they are in the formation of character, the good done by the school is, in many cases, lost for ever. Many reformers, more enthusiastic than wise, without regard to the immediate future of the child, strenuously advocate the inclusion of all manner of instruction in the primary school curriculum, *e.g.* cookery, laundry, household management, the duties of mothers, the care of babies, hygiene. There are very grave doubts indeed whether pupils from ten to fourteen years of age will benefit much by instruction in these subjects, and the doubts become almost certainties when the time from fourteen to twenty years of age is a period of educational neglect.

All observers of human nature agree that the period of life from sixteen to twenty years of age is a time of moral and religious stress. It is during this period that the rising generation needs the wisest guidance, the most sympathetic influence, and firm but tactful and cautious discipline. Primary school instruction and training only touch the fringe of the education problem. It is to the continuation schools that we must look for that wise and sympathetic influence, that training in habits, and that broad-minded instruction that will lead our maidens to be good mothers, and our youths to be manly, honest men, healthy in mind and body.

Instruction, then, in the moral and hygienic aspects of cleanliness could very well form part of the teaching in continuation schools. Even there it should be of a broad and general character. It should not be technical or detailedly scientific, but rather generous and inspiring, appealing not so much to scientific curiosity as to the growing feelings of citizenship and self-respecting manhood.

Skin Diseases.

8. There now remains to be considered the disagreeable subject of children suffering from skin diseases and from verminous heads and clothing. Cases of this kind, happily rare in many schools, are only too common in the schools situated in the slums of our large towns.

Ringworm.

The skin disease most frequently met with is ringworm. Ringworm is caused by a fungus, or vegetable parasite, that attacks the skin, and especially the roots of the hairs. It is therefore most frequently found on the hairy scalp, though any part of the skin is liable to be attacked. The disease shows itself in the form of circular patches, red and inflamed and covered with dry scales. When present on the scalp the hairs break off and leave circular bare patches. The disease is extremely contagious, especially among children, and can be carried from child to child by means of hats, towels, or hair-brushes. It should be remembered that any scale from the ringworm patch is capable of transmitting the disease to an unaffected child. In its early stages ringworm, if treated thoroughly, may be cured in a comparatively short time. But when it has obtained a firm hold on the skin it is very obstinate to ordinary treatment. When, therefore, a case of ringworm is found teachers should immediately adopt strict measures. Laxity may result in the rapid spread of the disease throughout the school. The affected child should be dismissed at once, and the case reported to the

school nurse and the medical officer, who will advise the parents as to treatment. The child should not be readmitted until certified by the medical officer as fully cured.

Verminous Children.

In the case of verminous children the following measures adopted by the London County Council have proved efficacious.

"The nurses visit the schools and select all children with unclean heads. A card, enclosed in a sealed envelope, with a part easily separable (line of perforation), is given to each child to take home.

"The card has on it simple directions for treatment, and a statement that children not treated after a few days will be separated from the others. The parent is requested to read the instructions, and sign and return the attached portion, or the child will be separated from the other children forthwith.

"On the front of the card there is printed:—

PRIVATE NOTICE.

Your attention is drawn to the condition of this child's head, which has been noticed in school. The school nurse has examined it, and states that by attention to the directions given on the other side it can be rendered permanently clean within a week. If cleaning is not effected by that time the child will have to be kept separated from the others in school until the unclean condition is remedied.

"On the back of the card:—

INSTRUCTIONS FOR CLEANSING HEADS.

Where there are sore places, scabs, or enlarged glands, these will generally get better on removing all lice and nits.

It is possible to effect a cure in about a week.

All hairs with nits and all hair within a quarter of an inch of a sore must be cut off.

The head must be washed and scrubbed daily with paraffin oil, to which an equal quantity of olive oil may be added. If there are scabs, these when softened should be removed.

Repeat this treatment daily for a week, then weekly till all signs of lice are gone.

Where there is difficulty in keeping a child's head clean the hair should be worn cut short.

Iron the collars of the clothes with a hot iron.

Caution.—Do not use paraffin near a fire or naked light.

"The attached portion reads:—

I have read the instructions on the back of the card and will endeavour during the ensuing week to get ——— into a healthy and clean condition.

Signed ———.

"At the end of a week from the nurse's first visit all cases not treated or not returning the card are separated from the other children, and cases not returning the card signed by the parent have a home visit by the nurse; if at the nurse's fourth school visit no attempt at treatment has been made, the case is notified to the School Attendance Officer, and a second card left at the home by him on which the treatment is again set forth, the failure to adopt remedy pointed out, and a statement that if at the end of a week (nurse's sixth visit) the child has not had treatment it will be excluded from the school, and that the parents or guardians will be liable to immediate prosecution."[1]

In school areas where school nurses do not exist the teachers should, with the consent of the school managers, carry on a similar crusade against personal uncleanliness. Children suffering from vermin should be separated at once from the others. The parents should be immediately communicated with and instructed how to treat their children. Failure to comply with the instructions should be followed by instant removal from the school, when the case falls naturally into the hands of the attendance department of educational administration.

[1] Quoted from Lyster, *School Hygiene*, pp. 223-225.

CHAPTER X.

FRESH AIR.

1. Free interchange of gases between air and blood and between blood and tissues is essential to vital process and functional activity. Fatigue we have seen to be primarily a condition in which there is a clogging of tissue activity by the accumulation of waste products; the cells of the higher nervous centres being particularly sensitive to their baneful influence. If, then, the oxygen of the blood be not renewed and its carbonic acid fully removed, symptoms of fatigue and of diminished vital power show themselves in headache, languor, lassitude, irritability, and a weakened power of mental concentration and of physical endurance. The free exchange of gases between the air and the blood is necessarily largely dependent on the character of the air breathed, that is, on the proportion of oxygen and of carbonic acid it contains. Usually the air contains ·04 per cent. of carbonic acid, but continued breathing in a confined space decreases the proportion of oxygen and increases that of carbonic acid. The latter ingredient may, however, be increased by ·02 per cent. of impurity to ·06 per cent. before any marked effect on the life and activity of the tissues becomes noticeable. Continued breathing of air vitiated to this extent will in the course of time, however, weaken mental power and physical endurance, and make the oncome of conditions of fatigue more rapid.

Impurities due to Breathing and their Effect on the Body.

Carbonic Acid.

When this measure of impurity is exceeded breathed air begins to have more marked effects on the system. To a person coming from the fresh air it smells close and stuffy, though perhaps its condition is not noticeable to one who has become accustomed to it. When above 1 per cent. of impurity is present headache and faintness are produced, and with increasing impurity there arrives a point at which the activity of the higher nervous centres is interfered with so seriously that insensibility follows. From a large mass of practical experience of the effect of carbonic acid impurity on vitality it has been generally agreed to consider ·02 per cent. the limit of permissible added impurity; though some observers as Carnelly, Haldane, and Anderson place it considerably higher, at ·09 per cent.

Temperature and Moisture.

Breathing, besides increasing the proportion of carbonic acid in the air, also increases the temperature and the amount of moisture. Expired air is saturated with moisture and its temperature approximates that of the body. Hence the results of the continued breathing of the air of a confined space are a gradual approach to saturation, shown frequently by the deposit of moisture on the cold surfaces of windows and walls, and a steady rise in the temperature of the air. Both these consequences have a marked effect on vitality. Tissue activity, as has been shown, produces heat, and the body is kept at a uniform temperature mainly by the loss of heat through the skin. It follows, then, that a rise in temperature, by diminishing the radiation from the skin, will hinder the life processes of the tissues, and this result will be all the more marked owing to the increasing humidity of the air diminishing the activity of the sweat glands. The debilitating and relaxing effects of a warm, 'muggy' day and the invigorating influence of a clear, dry, and moderately cold atmosphere, well illustrate the

action of moisture and warmth on the vitality of the system.

It is thus evident that the continued increase of carbonic acid, of temperature, and of moisture all play their part in the evil effects that breathed air has on the power of life and work, the symptoms of those effects being seen in lassitude, restlessness, and declining powers of attention. Dr. Kerr, Medical Officer of Schools to the London County Council, in his "Report on the Condition of the Schools and Scholars of London for the year 1907," gives the results of a number of experiments made with the object of observing the effects of increase of carbonic acid, of moisture, and of temperature on the work of the pupils. To quote from his report: "The London child takes little notice of variations of temperature between 56° F. and 64° F., and apparently does its best work about 58° F., but in this regard there are considerable individual differences. There seems to be no advantage whether the air at these temperatures is dry or saturated, or whether at rest or in gentle movement. A fall below 55° F. gives rise to comment, and a rise above 65° F. to unpleasant subjective symptoms in some persons. . . . With high temperatures, 65° F. or more, whatever other factors may be present, high or low proportions of carbonic acid gas, moisture or not, movement of air or rest, the high temperature alone has an evil influence in determining deterioration in the mental work in the children.

"On two occasions boys attributed headaches to the noise of the fan, but restlessness, inattention and listless attitudes were noticeable. Above 70° F., three or four children in the class got headaches, and others flushed faces, and this whether the carbon dioxide was in high or low quantity, or the air fresh, or unpleasantly stuffy from human exhalations. The only occasions with high

temperature where no mental deterioration was determined was when, with high carbon dioxide, and unpleasantly stuffy condition, the air was kept pleasantly moving by the fan. On occasions with 77° dry and 74° wet bulb readings, no subjective signs or mental deterioration was noticed when the fan in the room was thus kept working.

"It was found impossible under school conditions to obtain a high temperature, 70° or more, with considerable humidity, that is over 60 per cent. Possibly this may be obtained in suitable weather, and help to solve the question of what part humidity plays. Meanwhile, the conclusion seems justified that below 65° F. relative humidity plays no important part in affecting mental work. But humidity appears intimately related to high temperature and loss of body heat from the surface. The nearer the wet bulb temperature comes to the body heat, the more important physiologically it seems to be, as the difficulty of getting rid of heat increases disturbance in the metabolism, probably setting up toxic symptoms, first in diminished working capacity, flushing, and restlessness, and later by headache, sickness, and rapidly increasing and marked failure of working power.

"Carbonic acid gas in the usual concentration seems to exert no appreciable effect on mental capacity. Above 35 or 40 parts in 10,000, this may not be true. Dr. Brincker and Dr. Hogarth personally experienced subjective feelings as of a light band round the forehead and temples and round the chest, and although no effect in change of atmosphere was apparent to teacher or scholars the test showed, and the teacher actually noticed at the time, that after about an hour there was a remarkable collapse in the mental capacity of the children. They appeared exhausted mentally, whilst at the same time there was entire absence of the headache, oppression, and nausea, or

of the laziness, restlessness, and irritability shown in a hot close atmosphere alone. It yet remains to be determined whether there are not two trains of symptoms capable of disentanglement, due to different toxic causes, one from so-called 'heat retention,' the other an ultimate effect of carbon dioxide poisoning."

Dr. Kerr summarises the result of the whole series of observations in the following statements, which are borne out by the conclusions arrived at as to the cause of fatigue and reduced vitality :—

"(i) Mental alertness and accuracy are improved by two or three hours of school work, provided that the atmosphere is satisfactory.

"(ii) Temperatures above 65° F. give rise to definite subjective symptoms; slackness and inattention in some, headaches in others. Although it is not easy to assert definite mental alteration till about 70° F.

"(iii) Symptoms do not appear at 65° if the air is kept in gentle movement by a fan in the room. At higher temperatures the symptoms and mental conditions are ameliorated by such movement of the air.

"(iv) With temperatures 70° F. and above, other factors being normal, there are marked symptoms, and very evident deterioration in mental alertness and accuracy.

"(v) Relative humidity does not affect the mental capacity of children at low temperatures. Increase of humidity appears to increase the effects of high temperatures.

"(vi) Carbonic acid gas in considerable excess, although not producing symptoms found in a hot and close atmosphere, seems to produce, after a time, considerable fatigue in the performance of mental functions by the children." [1]

[1] Report of the Education Committee of the London County Council submitting the report of the Medical Officer (Education) for the year ended 31st March, 1907, p. 63.

Organic Impurities. It has been noticed already that breathed air contains organic impurities from the lining of the brònchial tubes, which together with the volatile organic substances exuded from the skin are responsible for the offensive smell and close stuffy 'feel' of breathed air. The effect of these impurities on the atmosphere and on health has already been considered and therefore need not trouble us here.[1]

Examination of Class Room Air. 2. Seeing the effect that foul air has on health, and on the power of continuous effective work, it is important that the teacher should know from time to time during the day the state of the air in the class-room in order that he may take measures to flood the room with fresh air if the foulness pass beyond the permissible limit. **Subjective Symptoms.** It is of little use, as has already been hinted, to rely on the sense of smell or the feeling of closeness and stuffiness. Those living in a room becoming gradually fouled fail to notice the state of the air until marked symptoms such as headaches, faintness, and sickness show themselves. It would, however, be wise, when listlessness, inattention, or bad work is observed, to consider whether it is not an indication that the state of the air in the room is not all that is to be desired.

Measurement of Carbonic Acid. The teacher has no direct means at his disposal for measuring the amount of carbonic acid and organic impurity in the air, though apparatus invented by Dr. Scurfield does exist by which the measure of impurity can with considerable accuracy be ascertained. It may be considered, however, that the rise in temperature, and the increase in humidity due to breathing, are roughly proportional to the amount of carbonic acid and organic impurity. As has been

[1] See Chapter IX., § 1.

shown, too, rise in temperature and in humidity are, in themselves, factors in bringing on fatigue and reduced vitality.

The degree of humidity can be measured by means of a wet and dry bulb thermometer. The moisture on the wet bulb evaporating into the air absorbs heat, and thus causes the reading on the wet bulb thermometer to be lower than that on the dry bulb thermometer. The dryness of the air is, then, proportional to the difference of readings. The greater the difference between the two readings, the greater is the evaporation from the wet bulb, and the drier is the air of the room. The less the difference, the less is the evaporation, and the more nearly does the air of the room approach the point of saturation. When there is no difference in the readings, the air is saturated, and there is no evaporation from the wet bulb.

Measurement of Humidity.

Every class-room in a school should be tested from time to time on typical days, about the middle and near the end of each school session, to ascertain exactly the condition of the atmosphere as regards its humidity. Though few teachers can at all times command the use of a wet and dry bulb thermometer, there should be one in use in every school for periodic testing of the class-rooms. Especially is such testing necessary when the rooms are warmed by heated air or by hot pipes. On ordinary occasions any deposit of moisture on the cold surfaces of windows or walls should be taken as a sign that the humidity of the air has passed beyond the health limit.

Measurement of Temperature.

The rise in the temperature of the air can always be readily measured, and can be taken as a more or less accurate indication of the carbonic acid and organic impurities and the degree of humidity. The continuous breathing of the air of rooms, even when it is regularly renewed, raises its

temperature. With a flow of air necessary to keep the impurities and humidity below the permissible limit, the rise of temperature due to breathing will be about 4° F. Any increase of temperature of more than 4° F. must be considered as a sign of defective ventilation. Of course the temperature may rise from causes other than breathing, such as fires, stoves, hot pipes, and sunshine. It is desirable, however, in cold weather, that the air of the class-rooms be warmed to near the proper temperature before the children enter.

It has been seen that temperatures from 55° F. to 64° F. are the most suitable for effective work, and it is generally held that the best work is done when the air is at a temperature of about 62° F. Hence, since the permissible warming of the air by breathing is 4° F., the temperature of the air at the beginning of the school session should be about 58° F. and not less than 55° F. With these initial temperatures the ventilation should be such as not to raise the temperature above 62° F. A temperature above 64° F., at any rate in cold weather, should be considered both as injurious in itself and as indicating too high proportions of carbonic acid and organic impurities.

If, however, fresh air at a low temperature is entering the room, it is impossible to keep the interior temperature between 55° F. and 64° F. without heating the air by breathing to an extent that will render it injurious to health. The incoming fresh air in winter, then, should be warmed to a temperature approximating to 58° F. There are further reasons why the difference between the temperature of the interior and that of the incoming air should not be much greater than 4° F. It will be seen later that draughts and cold feet are caused by too great a difference between the temperature of the air in the room and that of the air entering.

Thermometers, then, should be regarded as essential parts of the equipment of every class-room, and the teacher should be strict in his constant and regular use of them. One thermometer for each class-room is not sufficient. At least three are required: one for taking the temperature of the outside air; a second for taking the temperature of the lower stratum of air in the room, where the incoming fresh and colder air will most likely be found; the third for taking the temperature of the upper stratum of air, where the heated breathed air will tend to accumulate.

It has been seen that it is necessary for each teacher to know the ventilating power of his room on typical days in different seasons of the year. To effect this each room should be tested by means of the thermometers over intervals of a week at different hours until the ventilating

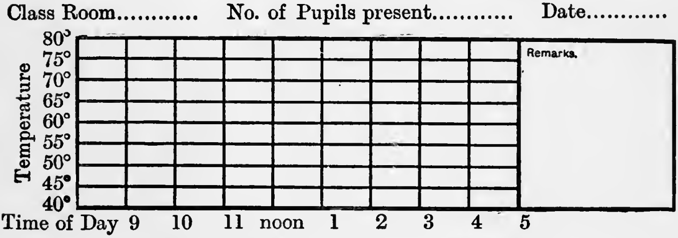

Fig. 14.—Diagram of Chart for Temperature.

capacity of every class-room is intimately known. Readings of the three thermometers should be taken at regular intervals throughout the day. The most convenient times for taking readings will probably be at the change of lessons. Particularly should the temperatures be taken at the beginning and end of the school session, and before and after the recreation interval. The most suitable mode of recording the readings is by means of a chart such as the one above.

Three curves will thus be obtained expressing the readings of the three thermometers throughout the day. It is important, however, to note down the number of children present, the length of the recreation interval, whether the room was flushed with fresh air during this period, during what periods gas-burners had to be lighted, whether the lessons demanded physical activity, as in music and drill, or quiet sitting, as in writing exercises, and what modifications were made in the means of ventilation. Any signs of fatigue or of collapse in attention, general throughout the class, should be noted.

Charts giving information such as the above would prove valuable in giving a thoroughly practical insight into the state of the room and its effect on health and work. They would be still more valuable if at certain times in the year the increase in humidity was tested by means of a wet and dry bulb thermometer, and the carbonic acid impurity by means of a Scurfield's Apparatus.

Such thorough testing is only necessary at intervals throughout the year, but observation of the thermometer should be part of the daily routine. Especially is this necessary when the tone and work of the class show that fatigue has set in. The effect of various lessons on the rise in temperature should also be noted, for during singing and drill breathing is quicker and deeper and the air is more rapidly fouled than during more reposeful lessons.

Principles of Ventilation.

3. The teacher, then, must consider the continual observation of the state of the class-room air as part of his daily routine duty, a duty as necessary to effective work as the preparation of his lessons. The observations, however, should always be made with a view to adapting the means of ventilation of

the class-room to the needs of the pupils. It is true that the appliances for ventilating the rooms of a school are matters of school structure and hence rest with the architect, but it is no less true that a great part of the success of the means provided will depend on whether the teacher makes the most and best use of the system. Undoubtedly a bad system can never be made to work well, on the other hand it is certain that a good system can through neglect or ignorance be rendered most ineffective. There are still many teachers who, even in summer, fail to open the class-room windows, and who, during the recreation intervals, never think of flushing the rooms with fresh air by means of open windows and doors.

Ventilation a difficult Practical Problem.

It is the duty of a teacher to know the needs of his class with respect to fresh air, by definite and well-considered examination to understand the problems of ventilation presented by his own class-room, and to make the most and best of whatever means exist. Head teachers in particular would be well advised to explain to their colleagues the system by which the school is ventilated, and to inform them of the measures that in the past have been found to be most successful. The problem of ventilation lies in removing the fouled air at such a rate, and supplying fresh air in such quantities, as to keep the temperature, the humidity, the carbonic acid, and the organic impurities below the limits permissible for health.

It is a matter of no great difficulty to compute the amount of fresh air each child should receive in order to keep down the proportion of harmful products, and quite easy to provide inlets of sufficient size to bring in fresh air and outlets of dimensions necessary to take away the foul air. It is, however, one of the most difficult of practical problems to secure that the fresh air from the inlets

spreads itself out through the room so that each child receives his proper share, and then that the foul breathed air flows directly to the outlets and is at once got rid of without accumulating in any part of the room or mixing unduly with the incoming fresh air. The problem is still further complicated when it is considered that the flow of fresh air must be sufficiently great to provide for a large body of children, and yet must not enter with such momentum as to cause unpleasant draughts. The problem, moreover, is never a constant one. It varies with the difference between the temperature of the outside air and that of the room. Winds considerably interfere with the ventilation, sometimes aiding, sometimes hindering. The means used to heat the room, whether by open fires, stoves, hot pipes, or heated air, present a further complication. Breathed air, too, has a distinct motion of its own. In the presence of so many forces, some hindering, some aiding, all more or less variable, it is obvious that the problem of ventilation is a complex one, and it is little wonder that in practice ventilation is so often unsuccessful.

Dr. Shaw, in his valuable book on the problem of ventilation, states the difficulties in his humorous way as follows: "I suppose the greatest social enemy from the ventilation point of view is the individual who sneezes; the person who merely breathes is bad enough, the person who sneezes adds a special difficulty because he distributes a cloud of fine particles which may or may not be deleterious. Imagine such an enemy in a remote corner of a large room and consider what must be done to wash away the respirable impurity. Some benevolent authority may have decided, perhaps, that 1,000 cubic feet of air per hour is sufficient for the work, because no signs of exceptional discomfort or illness have manifested themselves when

that amount of air has been supplied on the average. So every second a quarter of a cubic foot of air is duly provided for our enemy and delivered for him through an opening in the wall, which some say should be high up, others low down. At the same time the quarter cubic foot which was supplied for him some fifteen minutes previously is called for at another opening in another wall, which again some say should be low down and others high up. But how is our enemy with the sneezing cold to be sure of getting his quarter cubic foot, and how shall he be sure of giving it up when he has used it in such a way that it shall reach the proper opening for its removal? As a matter of fact, the distribution of the air supply between the occupants of a room is a matter of scrambling between them; and in the course of the scramble there is much scope for the exercise of various physical laws that are not much regarded in deciding the general practice of ventilation. Certain it is that, with a single opening in one wall for delivery and a single opening in another for extraction, if every occupant of a school class-room does get his fair share and use of the fresh air supply, it is a result that one could not anticipate."[1]

The Unit of Ventilation.

The first question that arises in ventilation is the amount of fresh air required for each child. It may be taken as a fair basis for computation that each child on the average breathes out ·4 cu. ft. of carbonic acid per hour. The quantity, of course, varies. When the child is at rest the amount is less, when physically active it is greater. It is less than the amount given out by an adult, which may be taken on the average as ·72 cu. ft. per hour. As the permissible limit of added impurity is ·02 per cent., the amount of air fouled

[1] Dr. Shaw, *Air Currents*, Preface, p. vii.

per hour will be $\frac{\cdot 4 \times 100}{\cdot 02}$ cu. ft., or 2000 cu. ft. in the case of a child and 3600 cu. ft. in the case of an adult, which means that the flow of air must be $\frac{5}{9}$ cu. ft. and 1 cu. ft. per sec. in each case respectively.

The velocity of this flow will depend on the air space of the room. If the air space per child be small the necessary amount of air must enter more rapidly than if the air space per child be large. The velocity of the flow, however, must not be too great. It has been calculated that with an air space per child of 200 cu. ft. the velocity of the incoming air will not be noticeable and will not give rise to chills. It is interesting to note that the Board of Education, by its regulations, considers 120 cu. ft. sufficient for a primary school child, while the minimum for a secondary school child is much greater. It is evident that the Board considers that the capacity of the average child to withstand the effects of suffocation is great, and greater in the case of a child in a primary school than in that of one in a secondary school.

The temperature of the incoming air has much to do with the presence or absence of draughts. If the temperature of the fresh air be near the temperature of the air of the room a much greater velocity would be less noticeable than a less velocity in the case of air considerably colder. It is important, then, for efficient ventilation of rooms containing many children to have the incoming air warmed in winter in order that the inward flow may be sufficiently rapid and yet not noticeable. We have seen already that the temperature to which it should approximate is 58° F.

Law of Flow. The first law of ventilation is that whatever quantity of air comes into a room the same quantity should flow out. Consequently, both inlets and outlets must be provided. Moreover, the amount

of air coming in or going out is determined by the size of the openings. It is obvious, therefore, that small inlets will restrict the flow out as well as the flow in, whatever be the size of the outlets, and small outlets will restrict the flow in, whatever be the size of the inlets. Theoretically it would seem that inlets and outlets should be the same in area, but it is found in practice that it is preferable to have slightly larger outlets. It is necessary to insist on the provision of both inlets and outlets of sufficient size, because in many people's minds there is an impression that if you make provision for air coming in the air will find its way out somehow, or that if outlets are provided for getting rid of foul air the chinks and cracks of windows and doors will be quite enough for the delivery of fresh air.

Circulation of Air in the Room.

The problem, however, is something more than simply bringing air in or taking air out. The circulation of air throughout the room and the velocity of its flow are important considerations. Taking these points into account the first practical principles of ventilation are that large inlet and outlet spaces should be provided so that large quantities of air can come in and go out with small momentum, and that the inlets and outlets should be distributed over as large an area of the room as possible and in such a way as to cause movement of air across the room. It will be readily seen that windows widely open will cause less draught than windows slightly open, and that it is better to open all the windows than only one. A current of air distributed over the whole side of a room is preferable to its concentration between the door or fireplace and one open window. Account must be taken, however, of the outside temperature. As will be more fully explained later, the admission of cold air in large or small quantities

high up or low down will cause draughts due mainly to difference of temperature.

The circulation of the air within the room is a difficult problem. It is complicated by the facts that there are at least two distinct sets of currents—*momentum currents* of incoming and outgoing air; and *convection currents*, that is those due to differences of temperature—and that these considerably interfere with each other. Many of the draughts which are supposed to be due to incoming air are really due to the action of convection. Convection, indeed, is an all-pervading influence in the circulation of the air in the room. Dr. Shaw specially emphasises its importance: "It is at once the condition of success and the cause of most failures. Without convection ventilation would be impossible; in consequence of convection nearly all schemes of ventilation fail."[1]

The law of convection is that heated air rises and cooled air sinks in the surrounding air. Hence every source of heat in a room causes upward currents, and every object colder than the air of the room causes downward currents. Fires, stoves, hot pipes, the warm walls around the chimney, warmth of skin, heated breathed air—all give rise to upward movements of air. Cold walls and windows, cold air entering give rise to downward movement.

Convection thus causes a vertical distribution of air in the room and also horizontal currents along the ceiling and floor, and since these currents are due to difference of temperature their velocity will be proportional to the amount of that difference. Hence, in a room occupied by a class of children there will be a general movement of breathed air upward, with a velocity dependent on the relation between the temperature of the room and the temperature of

[1] *Op. cit.*, p. 38.

the air coming in to take its place. This general movement will be interfered with by the action of fires, hot pipes, cold windows, and incoming fresh air. Cold windows on a frosty day give rise to very appreciable down draughts. Incoming air considerably colder than the interior air falls rapidly to the floor, whether the original current be directed upward or not, and whether it enter high up or low down. The further course of these currents will depend on where upward convection currents are taking place. Each person breathing is making his own upward current, besides which fireplaces and hot pipes are special sources. A fire will cause a direct draught along the floor between windows and fireplace.

Draughts.

Draughts, then, are not necessarily due to the momentum of the incoming air, but they may be, and often are, the result of the admission of air much colder than the air of the room, or they may be due to the existence of very cold and extensive window surfaces. The remedy for draughts may not be, then, to diminish the amount of incoming air, but rather to supply that air warmed, and to supply more of it, so as to reduce the general temperature of the room. "If complaint is made of draughts the proper remedy may be to supply more air—perhaps a little warmer—not less air a little colder or of the same temperature. The explanation of the paradox is that air is required to wash away the surplus heat as well as the surplus impurity, that the draught may be due to the united effort, in the way of convection, of the assembly of people, and that the effects of convection are less if there is more air with which to work"[1] and, we may add, more uniformity of temperature.

It is generally considered that a difference of more than 4° F. between the temperature of the incoming air and

[1] Shaw, *Op. cit.*, Preface, p. ix.

that of the air of the room will give rise to undesirable convection draughts. This is further confirmation of the principle of supplying air at a temperature approximating to 58° F. The incoming air will then be warmed through 4° F. by breathing and so keep the temperature of the room about 62° F.

In winter, when cold outside air is brought in, draughts cannot be avoided, no matter what contrivances are used

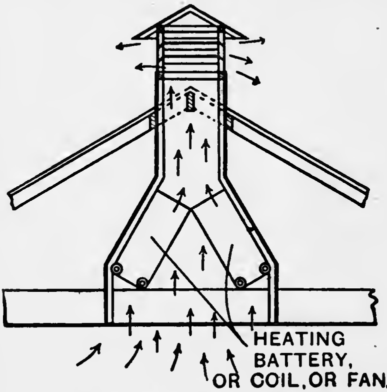

Fig. 15.—The most Effective Form of Air Outlet.

to direct the current upward. Cold air must fall to the floor. At such times there is an almost irresistible impulse to decrease the ventilation to a minimum in order to shut off draughts, an impulse strengthened by the desire to warm the room. There is thus a danger of the air being heated from a low to a high temperature mainly by being breathed, a process that on grounds of health and effective work is to be avoided at all costs. Warmth must not be obtained at the cost of health and work. "It is futile," Dr. Shaw remarks, "to try to keep a room up to

60° F. with an open window supplying at 28° F. the unit of ventilation for each occupant. The law of convection insists in such a case that an extremely cold layer will be found near the floor and the reversed correlative of the therapeutic action of putting one's feet in hot water will be set up. If you depend on unwarmed air in very cold weather adopt the open-air system at once and provide appropriate clothing. Uniform and draughtless cold is

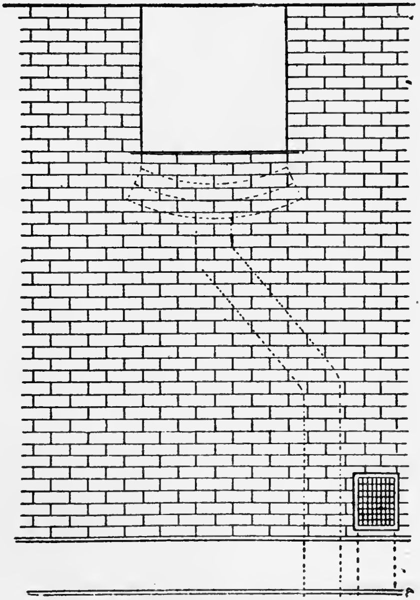

Fig. 16.—Chimney Breast Air Outlet.

not disagreeable to persons suitably clad. But marked differences of temperature applied to different parts of the body, like some other drastic remedies, should only be

used by special prescription of a duly qualified medical man."[1]

Ventilating Appliances.

4. The structural appliances for ventilation concern the architect and builder rather than the teacher, yet it is desirable that the teacher should be fairly well acquainted with the various systems and devices adopted in order that, in any particular case, he may make the most and best use of the system with which he has to work.

Outlets.

The positions of the outlets and inlets is the first point to consider, and in determining this the natural flow of air in the room should be borne in mind. Breathed air rises toward the ceiling, and

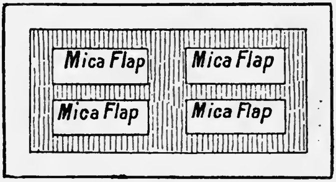

Fig. 17.—Boyle's Mica Flap Ventilator

it is good that it should do so, for it contains over one hundred times as much carbonic acid as fresh air. But since carbonic acid is a very heavy gas, the result of cooling will be the gradual descent of foul gas to the floor. It is desirable, therefore, that the heated foul air should escape before it cools and settles downward to the floor, and it is convenient to make use of the upward momentum of the air to help in its removal.

Outlets, then, should be near the ceiling. These may be perforated bricks, ventilating shafts through the ceiling or

[1] *Op. cit.*, p. 58.

passing up alongside the chimney stack, or open windows. The escape in the case of rooms occupied by large numbers of pupils should be aided by an additional motive power. Gas jets or small fans in the ventilating shafts, or a ventilating shaft warmed by being contiguous to the chimney, will induce a continuous flow. An opening into the chimney shaft itself may be provided, by which the

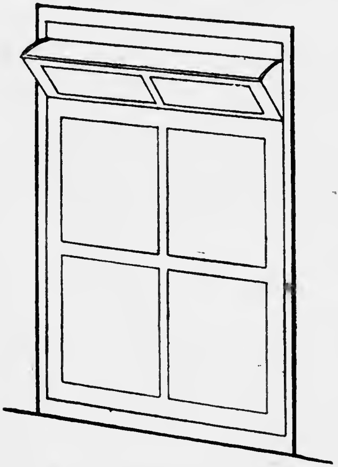

Fig. 18.—Hinged Top to Window.

strong upward current in the chimney will give rise to a continuous escape if the possibility of down draughts be avoided by the use of mica flap valves.

Figs. 15, 16, and 17 are illustrations of the devices mentioned above.

For purposes of light, as well as for ventilation, the windows should extend to the top of the room. If ventilating shafts or perforated bricks be not provided near the ceiling, all the space above the windows simply acts as

a receptacle for heated foul air, which, when cooled, sinks gradually downward towards the scholars. Figs. 18, 19, and 20 indicate some of the possible contrivances when windows are relied on for ventilation. Where no such devices exist the windows should be drawn down from the top.

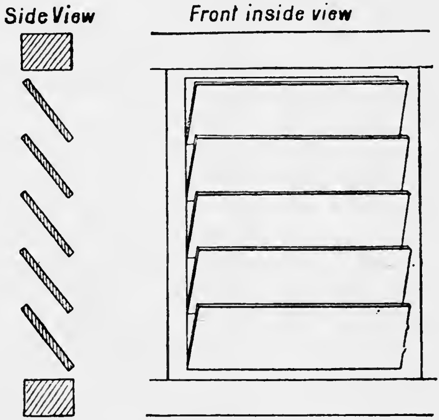

Fig. 19.—Louvre Ventilator.

It must be remembered, however, that the cold surfaces of the windows in winter will create a considerable down draught, and if the windows extend to the ceiling the air coming down will be just the air that is not wanted in the lower part of the room. Hence it is advisable to place hot pipes under the windows to counteract the down draught by an upward current of warm air, or to double-glaze the windows.

Inlets. The inlets for fresh air should be in the lower part of the room, so that the incoming fresh air may not mix with the foul air in the upper part of the room. Obviously they should be above the pupils'

heads, and the current should be directed upward in order to minimise the draught, although convection will bring the air down if its temperature is less than that of the air of the room.

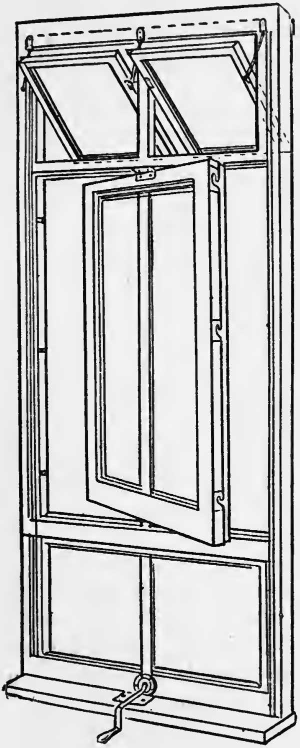

Fig. 20.—The Chaddock Window.

The devices adopted for inlets are usually Tobin's tubes or Sherringham valves (see Figs. 21 and 22). If the lower sash of the window is opened, then a thick glass plate inclined from the window should direct the current upward (see Fig. 23).

Mechanical Ventilation.

Where rooms contain large numbers of children reliance cannot be placed solely on the natural flow of air due to the heat of breathing or of fires. Continuous flow and a continuous source of energy are essential. If 2,000 cu. ft. be taken as the proper amount of fresh air per child every hour, then sixty children will require four tons of fresh air to be brought in, and four tons of foul air to be taken out every hour. Some of the motive force for this task is more or less constantly supplied by winds and heated air. But such forces are not always sufficient to cause a thorough and continuous exchange, especially in winter, when open

windows cannot always be relied on. Special motive force can sometimes be supplied by small fans and gas jets in the separate ventilating shafts for each room. In large schools, systems of mechanical ventilation by which the air is driven into all the rooms, or drawn out of them, by means of a large centrally-placed fan have been widely adopted.

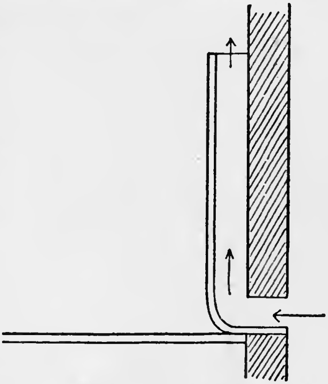

Fig. 21.—Tobin's Tube.

Plenum and Vacuum Systems.

These systems of ventilation involve considerable structural accommodation, and are, therefore, expensive to instal. The structure for mechanical ventilation consists of a large main inlet shaft, from which smaller ducts branch to each room. From each room there passes a second smaller duct, which enters a large main outlet shaft. The single fan can be placed either in the main inlet, and so drive air into all the rooms, or in the main outlet and draw air out of all the rooms. The former is known as the *Plenum*, the latter as the *Vacuum*, system.

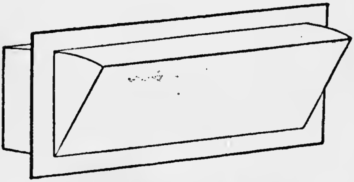

Fig. 22.—Sherringham Valve.

Obviously if air be driven in, its entrance is under control, but it will escape by any opening there may happen to be —a special outlet, an open window, an open door, or

miscellaneous chinks. On the other hand, if air be drawn out its entrance into the room is not under control. It will come in by any possible opening, specially constructed or otherwise. Where the air mainly escapes on the Plenum system, and mainly enters on the Vacuum system, depends on which openings offer least resistance to the flow of air. Open windows and doors, on account of their size, will naturally be preferred to the smaller openings specially provided. Little thought is needed to recognise the superiority of the Plenum system. It is obviously better to control the supply of incoming air in order that it may be warmed, purified, and moistened, than merely to regulate the outgoing air and trust to chance to provide the air which is to be withdrawn.

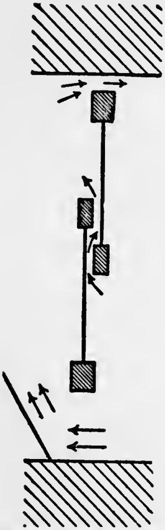

Fig. 28.—Diagram Showing Air Currents with Windows Open at Top and Bottom. Inward Currents Directed Upwards by Inclined Glass Plate.

One grave defect of both systems is the ease with which the equitable distribution of air to each room can be deranged. The main current of air entering divides into a number of streams, one for each room. These streams then unite into the main outgoing current. Obviously the resistance to the flow of air determines the amount of air-stream in each room, and this resistance varies inversely with the size of the openings. Where there is relatively small resistance the flow will be relatively great, and where the resistance is great the flow will be small. If, then, in any room the resistance to the flow is made unduly small by the largeness of the inlets an

outlets, or by open windows and doors, that room will attract by its small resistance an unduly large share of the air current. This is why the opening of windows and doors in schools ventilated by the Plenum and Vacuum systems immediately deranges the whole ventilation of the school; for the room with an open window attracts the flow to the detriment of the remaining rooms. It has been found advisable, therefore, to have sealed windows, and to issue strict injunctions against leaving doors open in schools where either system is installed.

The sealing of windows is one of the greatest defects of the mechanical systems of ventilation. In spring and summer the fresh air from open windows is a great boon. Air passing along shafts and flues seems to lose some of its freshness and invigorating properties. Moreover the flooding of rooms with fresh air from open windows and doors is an important means of purifying not only the air of the school, but its walls and furniture. Fresh air and plenty of it is a great purifier and invigorator. There are times, too, when the air in the school becomes too hot from injudicious warming, and the reduction of temperature when open windows and doors cannot be commanded is very slow and gradual. On all grounds it seems desirable to hold fast by our open windows and doors.

Zero-Potential System.

This disadvantage of the Plenum and Vacuum systems can to a large extent be overcome by placing a motive power in both the main inlet and the outlet shafts—one to drive air in, the other to draw air out. It is clear that by such means air must both come in through the inlets and go out through the outlets. Both incoming and outgoing air are under control. Open doors and windows will not under such a system cause any serious derangement. Such a double system, called by

Dr. Shaw the *Zero-Potential*, is much to be preferred to either of the single systems.

Advantages and Defects of the Mechanical Systems.

The advocates of mechanical systems of ventilation claim for them many advantages. There is no doubt that, if the difficulty of open windows can be overcome, there is much to be said in their favour, provided they are efficiently constructed and managed. The income of fresh air in the Plenum and Zero-Potential Systems is under control and can, with almost mathematical accuracy, be suited to the needs of each room by regulating the size of the inlets and outlets and the revolutions of the fans. The incoming air, too, can be heated to the desired temperature of 58° F. by being passed over hot pipes or through hot chambers. It can furthermore be purified by being passed through screens of rough hemp or jute or through coke filters, an operation much to be desired in some of the schools in our large manufacturing towns. Yet these benefits may through bad design or mismanagement become sources of serious trouble.

The screens, unless cleansed and disinfected daily, become sources of disease and dirt. The conducting shafts, too, should be regularly cleaned, and it is better that they be lined with glazed bricks to prevent the undue accumulation of dust.

The heating of the air may give rise to much trouble. Air passed through very hot chambers or over very hot pipes loses much of its vitality. It is uncertain what changes take place. Yet there is no doubt that the air so heated becomes deadened and devitalised. It has few of the stimulating properties of fresh air, and when breathed often causes headaches and more or less pronounced feelings of depression.

Heated air, too, becomes very dry, even though it con-

tains the same quantity of moisture as cold air. Humidity does not depend on the actual quantity of moisture in the air, but on that amount relative to the quantity required to saturate the air, and the amount required to saturate air rises with the temperature. Air at 70° F. will hold four times as much moisture as air at 30° F. and twice as much as air at about 50° F. Hence if saturated air at 30° F. be heated to 50° F. it will contain only 50 per cent. of the moisture possible, and if further heated to 70° F. only 25 per cent. Though at each temperature the actual amount of moisture present is the same, yet the saturated air at 30° F. would feel unpleasantly damp, the air at 50° F. a little dry, and that at 70° F. excessively dry. As has already been shown the relative humidity of the air influences the amount of evaporation from the skin. Too moist or too dry air disturbs tissue changes and affects health and vitality. Too dry air, moreover, gives to the skin a dry, rough feeling that is very unpleasant, and by its action on the delicate membrane of the throat and nose causes colds and catarrhs. Experience has shown that 60 per cent. of humidity is the most suitable for health.

A great disadvantage of ventilating rooms by means of heated air, then, is that the air is rendered too dry. Often the humidity of the air of schools warmed by heated air is reduced as low as 25 per cent. There are few people indeed who, working in rooms heated by hot air, do not have disagreeable feelings in the skin, and who are not liable to chills and to throat troubles owing to the great change of humidity and temperature experienced in passing from the inside to the outside air. Most people after living in the heated dry air of mechanically ventilated rooms on reaching the fresh outside air draw their breath with evident feelings of relief. Special means for moistening the heated air of mechanically ventilated buildings have

generally to be provided. Usually water is kept running over the hemp screen or through the coke filter. Even then it is seldom that the air attains the necessary degree of humidity.

When the ventilation is mechanical the teacher must always be a mere observer and often a passive sufferer. The system is essentially a centrally controlled distributing agency, and attempts at local adjustment only throw the whole arrangement out of gear. The central control of air and of heat should be in the hands of a capable man. Something more than a mere mechanic is needed. It is not mere engine-tending that is required, but the adjustment of a delicately balanced system that needs constant modification to the climate and to the needs of each class-room. There should, then, be appointed to control the system a man who thoroughly understands it and the various possibilities of air supply and of temperature. Managers should always keep in view the painful consequences of a breakdown or of any mismanagement of the system.

The teacher, as has been said, can only be a passive observer. He must never interfere with the system himself. But he can be of much help in giving information necessary for the adjustment of the distribution of air and heat. He should keep a constant watch on the temperature and the stuffiness of his room, and report immediately to the man in charge any deficiency of air or any undesirable temperature. It is his task, too, to test from time to time the humidity of the air by means of a wet and dry bulb thermometer.

Summary.

5. Throughout this discussion on ventilation we have endeavoured to keep before the teacher's mind the importance of fresh air in the school economy. Health, vitality, cheerful tone, and successful work may be jeopardised by ignorance or by neglect.

We cannot too strongly urge all teachers to interest themselves practically in the ventilation of their class-rooms and to know its utmost possibilities in all states of the weather. The following practical rules should earnestly be laid to heart:—

Open the windows at the top whenever the outside temperature is above 50° F. In warmer weather open them at the bottom as well.

After each lesson give the pupils some active drill, during which the windows should be widely opened.

During the recreation intervals and after school session, morning and afternoon, flush the rooms with fresh air from open doors and windows.

Finally, watch carefully for listlessness, restlessness, inattention, and other signs of fatigue in the pupils, and constantly refer to the thermometers to estimate the condition of the air in the room.

Instruction of Pupils in Ventilation.

6. Important as it is to convert the teacher into a fresh-air enthusiast, it is equally important that the pupils should share his enthusiasm. Undoubtedly the constant and unremitting attention of the teacher to fresh air will have its effects in the attitude of the pupils. They will become accustomed to breathing fresh air, an experience which, if sufficiently firmly established, will end in the longing for fresh air. The teacher should seize the many opportunities that are sure to present themselves to impress on his pupils the necessity of fresh air. He should train them to regard fresh air as being as essential to their well-being as food, cleanliness, and honesty.

It must be remembered, however, that the whole question is a moral one. "Thou shalt not breathe foul air" has no doubt its scientific justification, but as far as conduct is concerned it is a moral injunction which must be impressed

upon the pupils' minds in every practical way, but mainly by the habits of the teacher and his attitude to the presence of foul air if it be discovered. No doubt instruction on the effects of breathing and on ventilation will strengthen these educational forces, and pupils may be led to be deeply interested in carbonic acid gas and the laws of convection if suitable practical demonstrations are exhibited to them. But if such instruction only tends to awaken intellectual curiosity it is doing no good, but harm; for it is training the pupils in the habit of regarding knowledge as something intended only to satisfy intellectual curiosity, whereas the only knowledge worth having is that which influences conduct.

The pupils should become co-workers and partners with the teacher in managing the ventilation of the room. By turn the older pupils should be responsible for opening the windows during recreation intervals and at the end of lessons. By turn, too, they should be allowed to observe the thermometers, the readings of which they should write publicly on the blackboard for all to see; the teacher, of course, should explain why such readings are taken. The variations in the thermometer will provide good material for the teaching of graphic representation, after which a thermometric graph can be constructed daily by some responsible pupil and pinned in some public place. It is by entering fully and rationally into the 'fresh air' life of the school, by becoming convinced of its importance by the constant precept and example of all the teachers, by learning its aim and methods by practical experience, that the pupils will come to make fresh air not merely something to write learnedly about, but a principle and an ideal woven into the woof of their daily habits.

CHAPTER XI.

BODILY ATTITUDES.

School Life and Bodily Activity.

1. School life has become largely life in a class-room in which the pupils spend most of their time sitting in desks engaged in reading, writing, drawing, sewing, or receiving oral instruction. They seem always to be chained by strong, though invisible bonds, to their desks. True, the monotony of it is at times varied by an excursion to the drill hall or to the workshop, and occasionally a teacher strives to still the restlessness of his charges by a few minutes' physical exercise, but in the main the custom of the schools is to do everything possible at the desks. What cannot be done there is too often looked at askance as a disturbance of the regular orderly routine of the school, something to be tolerated as the whim of an inspector or the fad of an official. There is unfortunately too much ground for the charge that school life is not so much adapted to the growing activities of the child as to the possibilities of the desk at which he sits.

Some teachers there are, too, who, not satisfied with the unnatural repose of desk life, seek to prohibit all movement of tongue or limb, all motion of mind or body, except that expressly performed at the command of the autocrat of the class-room. They seek to impose a gloomy silence and a statuesque immobility by an iron rule. The Red Indians,

we are told, were trained to stand like statues, and the monks of the Middle Ages voluntarily adopted a life of asceticism in which the body was subjected to the soul. The methods, if not the ideals, of the Indians and the monks seem yet to be with us. Many are the children who, for five hours a day for ten years of their growing lives, sit mute and motionless, hardly daring to move lip or eyelid, to turn face or body, or even to think except when expressly bidden. The child life which should be one of gradually expanding powers of mind and body becomes one of repression of all activity, a life cramped and confined to a few mechanically performed motions that custom has handed down as traditional.

With such a school life can it be wondered at that many of our children grow up stunted in body and with minds from which every spark of initiative has been stamped out? Fortunate it is that Nature has implanted in the child an impulse to mental and bodily activity which is hard to kill. Repress it in school and, like a stream dammed back, it will burst forth with greater violence and with irresistible licence when school time is over. Let the school life be as unnatural as it will, the child, out of school, will find some vent for his pent-up curiosity and his instinctive love of action.

"Order," some teachers say, "must be preserved in school." What a distorted and perverse idea of order it must be which rests on the negation of activity, of initiative, and of all the natural impulses of the child towards a life of action! Order of any human kind surely is a method of doing, not of refraining from doing. School discipline should be the orderly activity of mind and body, not the Dead Sea stillness of mental and bodily stagnation. Work, action of mind and body, is the essence of a school life in touch with real life, and the orderly methodical direction of

work and action towards ends of value is the spirit of its discipline.

The child is not naturally silent and motionless. When left to his own instincts he is ever on the move, pulling things to pieces with a restless curiosity, probing with eyes and fingers into everything, exercising his powers of instinctive imitation and invention at every turn, making, constructing, playing the man in so far as he conceives him. His eyes and fingers are never idle, his body never still. Only the mentally dull and the physically sickly desire repose of mind and body. It is by the continual exercise of all his powers that the child develops, and fortunate it is that nature, in granting him powers of mind and body, has also instilled in him the impulse to use them.

In the child and youth these instinctive powers develop mainly through bodily action in the active perception of things and in the using of them. If school life is to make the most and the best of youth it must not run counter to this natural tendency. School life should be largely a life of action. It should, however, seek to be more than play. If left to himself the child seeks pleasure and enjoyment; incidentally his play may educate and develop his physical and mental nature. That is the way of unaided nature. The school, on the other hand, makes the development of his physical and mental powers of primary importance, but should develop these in such a way that the child gains pleasure. The school should not only draw out and exercise his active self, but should develop it to something higher, better, more rational and more self-conscious.

Restless activity, curiosity, initiative, action, movement of body and mind are, then, the very breath of a school life in harmony with natural development. With the very young these begin in play for play's sake, but the school early seeks to turn play into work, aimless curiosity into

educative interest, impulsive originality into rational purposive invention, random action and movement into skilled work. Such an aim cannot be fully realised by the sedentary desk life of the class-room.

Evils attending a Sedentary School Life.

2. Sedentary occupations, it has been seen, are hurtful to the body.[1] Circulation and respiration are thereby reduced to a minimum and the vital processes of the body stagnate. The skin, liver, and kidneys become sluggish and the blood, retaining its impurities, paralyses the life processes and functional activity of all the tissues. Listlessness and irritability consequently result, and fatigue soon follows mental or bodily exertion. Harmful as a sedentary life is to the adult whose body is fully formed, it is doubly harmful to the growing child and youth. If, then, growth is not to be weak and stunted, if the body is to develop to the utmost of its capacity, it must be kept in active motion.

Narrowness of Mental Life.

Stunted in its vigour as the body becomes by the desk life of the schools, the injury to the mind is equally great. The body, it has been seen, is the servant of the mind, and the mind can only develop by the proper use of bodily activities. It is by the active use of his senses in seeing and handling and moving objects, and in the endeavour to gain this or that control over things in forming them to his will, that the child develops in mental power. Knowing a thing and knowing about a thing are not the same, though often mistaken for each other.[2] To know a thing is to be able to use it. Much of this kind of knowledge can only be obtained in practical action, in dealing with things in a practical

[1] *Vide* Chapter VIII., §§ 1 and 2.

[2] *Cf.* Welton, *Principles of Teaching*, Chapter I., pp. 9-10.

way by an exercise of practical skill, a way not altogether consonant with desk life.

Injury to Eyes and Powers of Movement.

A desk life cramps the pupil's field of perception and action and thus warps his body and mind. By it his powers of sense and movement are only exercised in the narrow field of actions that can be performed in desks. Larger and stronger movements of the body and limbs, with their correlative perceptions, cannot come within the scope of desk life. It results that in the school life of to-day there is an over-encouragement of fineness in seeing and in doing. The eyes are too often and too long exercised over small and delicate work, the hand is too early used and too closely confined to small and fine work in writing, drawing, and sewing. Statistics only too plainly show the evil of such a course. Eye troubles are found to become increasingly prevalent as the school age advances—evils that are mainly attributable to the long continued use of the eye over near and fine work at desks. Were all the bodily powers of sense and movement fully exercised in a judicious mixture of delicate and of broad larger actions, such evils would not follow.

Bodily Activity in the various School Subjects.

3. School life, then, should not be limited by the possibilities of the desk. It should become broader and more active, and lend itself to the development of the larger skilled actions as well as of the smaller and more delicate. Almost every subject has some part or aspect that calls for an active mode of learning. Arithmetic and geometry are essentially practical, though the practical side seldom finds its place in the school curriculum. The pupils should often be busy measuring the desks, the floor, the walls of class-room, hall, and staircase, and finding the area of the playground, the height of the school walls and

of trees. For larger measurements excursions should be made to a neighbouring field or recreation ground.

The progressive study of the country side, of its trees, shrubs, and flowers, and the surface of the land, presents numerous opportunities for out-of-door work. Visits to castle, church, abbey, and museum should bring history into real touch with the world. Carving, modelling, and handicraft are necessary branches of school study. Not only do they train the senses and skilled movement of both the larger and the finer orders, but they develop a sense of beauty and a knowledge of form that are very desirable.

The school-yard, the gymnasium, and the playing-field, if such exist, should be in constant use by some class or other for organised games and the more regular and intensive gymnastic exercises. There is thus very little reason, if the teacher takes a broad enough view of his work, uses his native ingenuity and initiative, and makes the most of his opportunities, why school life should be at all sedentary. The remedy lies in the teacher breaking away from traditional desk methods and taking a little trouble to encourage and to make use of the children's instinctive love of action.

School life, then, if looked on widely as a practical training for a practical life cannot be wholly a life in the class-room. Indeed there should be no day in which the whole time is spent within its walls. Nor need the class-room life itself be wholly sedentary, with the consequent bodily stagnation. It should be the aim of the teacher not to have two consecutive lessons wholly desk lessons. Certainly no two consecutive lessons should be devoted to fine desk work such as reading, writing, drawing, or sewing. We have already recommended that every lesson should be followed by a few minutes'

drill or music, both that the room may be flushed with fresh air, and that the bodily processes may be quickened and stimulated.

Many exercises can be carried on as well standing as sitting. Breathing, enunciation, and pronunciation exercises in both music and reading lessons may with advantage be taken standing. Often, too, in oral lessons standing for a few minutes is a decided relief. Arithmetic and drawing lessons should not always be carried on with the children in desks, where the more delicate hand movements are employed and the eye is exercised over fine work. Wise authorities would provide suitable writing and drawing surfaces, by preference not black in colour, in some of the school class-rooms, so that pupils could take their places there standing for arithmetic and drawing practice.[1] Bolder, freer arm movements would thus be trained, and the eye would not be injured by prolonged use over smaller and finer paper work.

By such means the harmful desk life, so prevalent in our schools to-day, would be greatly reduced in amount. It cannot be wholly abolished, nor is that desirable. It has its place. The aim of the wise teacher should be to give it its proper place. Everywhere we should endeavour to bring school life into harmony with the natural forces urging the child to action. Thus school life would be freer and more active, and mental and bodily powers would develop more broadly and harmoniously than under the desk life so common in the schools of to-day.

4. Pages have been written about the evils of school desks, and much ingenuity has been expended in endeavouring to devise a perfectly hygienic form of desk. It has, however, been generally taken for granted that the prevalent

[1] See Welton, *Principles of Teaching*, Chap. XIV., § 12.

system of desk life will continue without modification.

Conditions of a Healthy Desk Life.

If school life is to be largely a desk life, then every means must be taken to prevent as many evils as possible, and remedial measures must be devised to counteract those that cannot be removed. The main evil, however, lies in too prolonged and continuous use of desks. No ingenuity in desk adjustment or care in counteracting evils can turn what is eminently a sedentary life into an active one. We must chiefly urge that the nature of the school life should be changed. From being mainly a sedentary it should become largely an active one. No rational person can approve of a system of education that stunts the mind and deforms the body. The remedy for such a system is not to be found mainly in adjustable desks and in medicinal gymnastics, but rather in a fundamental change in school life itself.

Nevertheless, a wise care should be exercised in the choice and use of desks. Besides the general physical stagnation that follows from an abuse of desks, special bodily deformities attend their careless use, especially when they are faulty in construction. These deformities are lateral curvature of the spine, restriction of the chest and abdomen, eye troubles, and a slouching and round-shouldered gait. It must be held, however, that these evils come from an abuse and not from a proper and careful use of desks, and the chief abuse is the long continued sitting and writing attitude. Cramped and strained attitudes do no harm if indulged in only occasionally. Yet it is obvious, in view of the evils arising from improper sitting, writing, and reading postures, that every care should be taken to choose suitable desks and every persistence used to train the pupils to sit and work at them in attitudes that will not lead to positive physical harm.

Sitting and Writing Postures.

In sitting and working at desks the body should be held upright to give freedom for the chest to expand, and to prevent restriction and pressure on the abdominal viscera. The abdomen contains many large arteries and veins, and pressure placed on these by stooping attitudes hinders the circulation and may lead to serious digestive troubles. To maintain an erect attitude with comfort and ease the body requires to be firmly supported by the back-rest, the seat, and the floor. Sitting upright without adequate support quickly tires the muscles of the back and shoulders. Even when the body is adequately supported long continued sitting will fatigue these muscles, and the shoulders will gradually become rounded and the back bent. Relief is sought in change of attitude by which the fatigued muscles can be rested. Standing, walking, moving the arms and body, are antidotes to long continued sitting.

Form of Desk: for Sitting.

The seat of the desk, then, should be of a form to aid upright postures. The back-rest should be shaped to support the back and should hold it firmly just below the shoulder-blades. Girls, it should be noted, need a higher support than boys. The thighs should be horizontal and the feet placed firmly on the floor, from which it is obvious what the height of the seat from the floor should be. The arms should hang loosely by the side or be placed loosely in front or clasped loosely behind. The evil practice of folding the arms tightly in front cannot be too strongly condemned. Yet, though its effects on breathing are plain to the slightest thought, the practice is still common. The arms folded behind is a position that is beneficial during short periods; if long continued, however, it becomes very fatiguing.

for Writing.

The form of writing-slope and its relation to the seat are extremely important if physical evils are to be avoided when the pupils are working at the desks. Stooping, lateral curvature, constriction of the abdomen and chest, and eye troubles, all arise from a neglect of these particulars. To encourage an erect carriage when the child is working at the desk, the writing-slope must not be too distant from the seat. The edge of the slope must almost abut on the abdomen when the body is

Fig. 24.—Desk and Seat arranged in Minus Position.

held upright. It will then be found that a line drawn vertically down from the edge of the slope will project over the edge of the seat by an inch or so. This is called the 'Minus Position' (see Fig. 24).

The height of the writing-slope from the floor should be such that the writing arm can be placed comfortably on

the slope without raising the shoulder or stooping forward. If it be too high the spine is curved to the left, if too low the body is bent over the work. To prevent still further this latter posture the slope should be inclined at not less than 15° to the horizontal.

for Reading.

A desk with seat and slope overlapping is clearly more suited for writing purposes than for reading, and standing movements in it are very much restricted. For reading purposes our aim should be to diminish the risk of eye troubles by preventing stooping and bending the head. The book should be inclined at about 60° to the horizontal, and should be at least twelve inches from the eye. To fix this position for reading many desks are arranged so that the front half of the top turns up into a reading-slope at a suitable angle and at an appropriate distance from the eye. Such a form has many objectionable features. A slope with a marked crack across it is undesirable in writing, and necessitates a writing-pad when sheets of paper are used. The danger to children's fingers is considerable. Such a reading-slope, too, is unsuited to the methods of work the older pupils should adopt. Much of their desk work requires reading and writing to go on together. For work of this kind a light metal reading-slope which can be moved to any distance is to be preferred. For ordinary reading lessons the pupils can hold their books in their hands, as they —and other people—do in ordinary life, keeping them well away from the eyes.

for Standing.

For the pupils to stand at the desks with comfort and to get in and out of them with ease some device must be adopted. Some forms of desk attain this end by a writing-slope that moves backwards and forwards in a horizontal direction; others by means of a seat that can revolve upward. Difficulty, however, only

presents itself in an acute form in dual desks. With single seats the possibility of free movement is much greater. Dual desks are on several grounds objectionable. Doctors condemn them in that they conduce to the spread of disease; teachers in that they make independent work difficult. Single desks are on all grounds but expense much to be preferred, failing which the form of a long desk with a separate seat for each pupil has a great deal to be said for it. It is more convenient to the teacher in examining work to be able to pass behind every pupil than to pass up the rows between the desks.

Desks suited to Stature of Pupils.

The form of desk, then, must satisfy many requirements. It must be suited to the stature of the pupils, be convenient for writing and reading, and allow freedom of movement in standing. The greatest difficulty lies in providing desks to meet the various statures of pupils in the same class. Pupils of the same age may vary even as much as twelve inches in stature. Many desk-makers supply desks with adjustable slopes, seat, and back-rest, and many educational experts recommend them. Their recommendation, however, is generally on the assumption that school life is to be largely a sitting life. Sitting and writing at desks, as has been seen, should not form so large a part of school routine, and hence the necessity for fine and precise adjustment to stature does not arise. It is wise to fit the desk approximately to the pupils. Exactitude to an inch or so is immaterial if the desks are not in constant use. It is long-continued postures that fix in the physical frame the evils of sitting and writing. At least four sizes of desks should be provided in an elementary school, and three of them should be found in every class-room, so that the large and small children may find equal comfort and health with those of medium size.

Training the Habit of Sitting and Writing in Correct Postures.

However accurately the desks be fitted to the pupils, physical evils will still follow a bad use of them. Unhealthy postures are, in practice, as frequent in good desks as in bad ones. The enthusiasm of the doctors, the ingenuity of the desk-makers, and the money of the ratepayers seem to be of little avail in face of the neglect of the teacher and the perversity of the scholar.

Symmetry of attitude is alien to the instincts of the young, who love continual motion and change. The natural genius of the child finds its delight in curious contortions and strained positions. In his efforts at writing and drawing he screws his head round, works his tongue in and out, curls up his legs, and twists his body. An erect attitude, square to the desk, seems the last one he will adopt of his own accord. Such contortions and postures, however, are largely involuntary and unconscious. The motor impulse to write spreads itself out over his frame without control or restraint. There is wasteful profusion of movements, many of which hinder each other. In learning to write and to draw the child has not merely to gain control over the muscles that are directly concerned in making the strokes and curves, but has also to inhibit the involuntary motor impulses to the rest of the body. Perfection in inhibition is as slow and as gradual of attainment as in direct control of movement. The inhibition of irregular movements and improper postures must go on persistently and continuously until control over the general bodily attitude is automatic.

Training in correct posture must begin and proceed with the teaching of writing. It is as important a part of the teaching of writing as is the training in the control of the pen and pencil. In the early years of school life

the correct attitude should be shown to the pupils at the beginning of each writing lesson. Posture drill is at least as necessary as pen drill. But, as in teaching all other kinds of practical conduct, merely talking about a thing is of little use, and the formal and somewhat artificial practice in preparatory drill is by itself not much better. These are but preventive and precautionary measures. The real learning by the pupils is done in their practice under actual writing conditions, when their attention is divided between making the letters and maintaining the correct attitude. During the learning to write, then, constant and persistent effort must be made by the pupils in maintaining the correct position, and this demands as constant and persistent an effort by the teacher in watching and correcting each individual child.

The training of a good writing posture rests almost entirely with the teacher. We are firmly of the belief that, though some of the common evils are due to imperfect desks, more are the result of the neglect of the teacher. Certainly, if stooping and slouching are at all general throughout a class, we should be inclined to attribute the fault to the carelessness of the teacher rather than to the imperfection of the desks.

Upright Style of Writing.

An erect position, square to the desk, necessitates the adoption of an upright style of writing. All sloping styles tend to twist the body and to hinder direct vision, and in them the pen is held in a more cramped and fatiguing way than is required by the upright style. Sloping styles, moreover, have the further disadvantage of not being as legible as the upright style.

In writing the latter style the paper should be placed square with the desk and directly in front of the pupil.

The right arm should rest comfortably on the desk and the hand lightly on its side. The support provided in this way by the hand, wrist, and little finger will not only make writing less fatiguing, but give freedom of movement to the pen. It will be seen that the pen, instead of pointing to the shoulder as in writing the sloping style, points outside the shoulder.

The muscles of the fingers should not be strained in grasping the pen. Straining the fingers and gripping the pen only result in stiff, cramped, and stilted writing. A light easy hold gives freedom of movement. No strict rules concerning the holding of the pen should be laid down to be rigidly followed. Each individual, though conforming to some general form of posture, has his own peculiar way of obtaining ease, comfort, and freedom of movement. Moreover hands are not all formed on one model. Proportions vary a good deal, and this gives a strong reason for individual variations of the general mode of holding the pen. Thus, provided the posture be a healthy one and the writing legible, it matters little what idiosyncrasies of position and holding the pen each pupil adopts.

The position of the left arm is an important factor in maintaining a healthy erect attitude. The left arm should help to support the body and is needed to keep the paper firm for writing. For these purposes the arm from the elbow to the wrist should be placed near to and parallel with the front edge of the desk, with the hand lightly spread over the bottom of the paper or book. Only with the left arm in this position can an upright attitude be maintained for long. On no account must the pupils be permitted to slide the left elbow up the desk or to lean the head on the left hand. Both these attitudes are lazy, slouching, and harmful.

Position in Standing.

5. Standing, as has been suggested, should be an attitude in frequent use in the class-room. Indeed there are many kinds of work that are better performed when the pupils are standing than when sitting. During singing and oral reading the chest is more free to expand when a standing posture is adopted. In the larger movements of the arm and shoulder used in free-arm drawing, writing, and figuring, a standing position gives the best action.

As in writing and sitting, so in standing and in walking, the most suitable posture is that which gives the freest play to the chest, the least constriction to the abdomen, and the firmest and easiest support to the body and head. The body should be held firmly and easily on the legs, the feet being placed somewhat apart, and for long-continued standing one slightly in advance of the other. The knees should be braced back so that there is a feeling of power and elasticity in the support given by the legs. The body should then be capable of free yet well-controlled movements to right and left, and of being poised on the toes with perfect ease. Indeed, to raise and lower the body on the toes easily and freely is a fairly good test of a firm standing position, and the practice of such a movement is very beneficial in strengthening those muscles of the legs, body, and neck that are used in maintaining an upright carriage.

Firmly yet easily supported on the thighs, the body should be held upright, the chest out, the shoulders back, and the abdomen in. The head should not be bent forward, but held erect, a position very important in reading and singing exercises, when free action of the larynx and unrestricted breathing are required. In free-arm drawing and figuring the pupils should be almost at arm's length from their work, so that the large sweeping movements of

the arm and shoulder can be practised. Mere wrist action is unsuited to blackboard work.

Remedial Exercises.

6. In every posture—in sitting, writing, or standing—an erect upright carriage is most desirable. Any tendency to stooping over work, slouching, rounded shoulders, or bending the head forward should be corrected. An upright carriage naturally brings into action the extensor muscles of the back and neck. Fatigue or weakening of these muscles causes the body to stoop and the head to incline forward. Obviously, then, it is desirable to strengthen these muscles in every possible way, and at the same time not to fatigue them by maintaining one attitude, either in sitting or in standing, for too long a time. Standing, and arm and body movements, are as great a relief after sitting or writing as sitting is after prolonged standing. Hence it is good after a sitting lesson to have a few minutes' active physical exercise and to follow a sedentary lesson by one of a more active nature.

The physical exercises after a sitting lesson should be devised so as to counteract the evil results of sitting. They should be active enough to promote circulation and respiration, should expand the chest, and help to brace the body into a firm and erect, yet free and elastic position. Raising and lowering the body on the toes, combined with deep inspiration and controlled expiration, bending the body backwards, extending the arms outwards or above the head, and forcing them slowly behind the back are suitable forms of remedial exercises. These and other exercises will do much to counteract the evils attending desk work.

Yet, as has been insisted on throughout, school life should not be organised on a plan that necessitates medicinal treatment as an integral part of its methods. School life

should be healthy in itself, and so should be to a large extent a life of action. The remedy then for the evils of desk work, we must insist again, is not to be found chiefly in adjustable desks and remedial exercises, but in combining with the desk work a suitable amount of physical activity in the playgrounds, gymnasium, playing-fields, and workshops. These are the natural antidotes to sedentary pursuits. Still further may the evils be avoided by adopting the standing attitude in lessons that permit of it, in instituting class work at wall blackboards, and in insisting on a healthy posture being maintained whenever work at desks is being done.

CHAPTER XII.

THE CARE OF THE EYE.

General Law of Growth.

1. The child is born with unperfected bodily powers. It has organs of sense, movement, and of organic life that are undeveloped and immature, but which possess possibilities of perfection that may or may not be realised. How far the organs develop the full measure of their capacity depends on the kind of work they are called on to do during the period of growth. Exercise is the only royal road to development, but it may be a development of deformity and weakness, not one of full strength and power. Overwork exhausts and weakens, and work of a one-sided and limited character will deform. For growing organs are plastic. Growth requires that they be so. But in this very plasticity there lies a grave danger. In performing its work an organ is put under a certain amount of stress and strain, and being plastic it tends to adapt itself to the kind of work it is forced to do. With varied work of suitable quantity the organ grows to strength and to a power of functioning of a wide order; confined to work of a one-sided and limited character it is strained to deformity, and when it reaches maturity is incapable of exercising the full measure of its original capacity.

The harm, however, is not confined to any one organ. The organs of the body are so dependent on each other in carrying out the work of the organism that conditions of

work detrimental to the full growth of one organ are detrimental to all those that work in correlation with it. As has already been shown in the previous chapter, when the action of the muscles is restricted to work of a fine and delicate kind, not only do the muscles themselves suffer from want of sufficiently vigorous work, but the whole organism is injured to some extent by the inactivity. The vital organs stagnate for lack of a stimulus to circulation and respiration. The motor centres for the larger movements of the body and limbs remain undeveloped, and the correlative perceptions of sight, touch, and movement that are needed in the performance of the larger and more vigorous work of life are not experienced. The eye, too, is limited in its action to objects at short range, and eye defects follow.

Speaking, then, of the body as a whole, the sense organs, the mechanism of movement, as well as the organic system, will develop harmoniously by means of exercise, wise and judicious in character, widely varied in its nature and appropriate in quantity. Insufficient and inappropriate exercise will stunt both mental and bodily growth; overwork will weaken; one-sided work will deform. And this principle of growth applies to the eye equally with every other organ of sense or movement.

School Life and Eye Defects.

2. The eye is a sense organ that is imperfectly constructed at birth. Being more or less plastic, it will become at maturity a normally perfect eye, capable of performing the work usually demanded of it, only if it is used in a wise and judicious manner during the period of its growth. Unfortunately the school life of to-day is detrimental to the proper growth of the eye. All observers are agreed that as school age advances the proportion of short-sighted eyes among school children increases. Defects begin to

show themselves even in the infant school. As many as two per cent. of infant school children have developed short sight, and by the end of school life at fourteen years of age that proportion has increased to fifteen per cent.

In his examination of the eyesight of children in the schools of the London County Council Dr. Kerr found that as many as fifteen per cent. of seven-year-old children had moderate deficiency of vision, while four and a half per cent. had distinctly bad sight. At the age of eight these numbers had increased to sixteen and seven respectively. This increase of short sight as the school age advances points clearly to the hypothesis that the conditions of school life are, at any rate to some extent, responsible for eye defects. At the same time those causes of ill-health and stunted physique that are operative in the home life of the children must have their share in causing weakness of the eyes.

There can be little doubt that during school life the eyes of the pupils are misused to a considerable extent. They become deformed by being used for work of a one-sided nature. The eye of childhood is capable of considerable range of work, a range larger indeed than that of an adult's eye. But perfect growth requires that it be not used too often and too continuously for delicate fine work at a short range. It is just this kind of work, however, that modern school life forces on the eye. In the class-room the eyes are required to adjust themselves to two ranges only, from ten to thirty feet in oral lessons and from ten to eighteen inches in desk work. Work at this latter short range is, moreover, usually of a fine and delicate kind and compels the pupils to peer closely at their work and to bring it as near as possible to their eyes. Writing, reading, sewing, pencil drawing, painting, and many forms of hand and eye training are all of this character.

Such work is not wholly unsuited to the power of the child's eye. Occasional exercise at fine and delicate work would do no harm; for the eye, like all organs, has a wonderful recuperative power. It cannot, however, withstand the strain of long continued and persistent exercise of one limited type. Prolonged use of the eye at short ranges and upon delicate and fine work will result in deformity.

Structure of the Eye.

3. To understand how deformity is brought about it is necessary to grasp, in main outline, the structure of the eye and the movements made by it in performing its work at different ranges.

The Eye an Optical Instrument.

The eye is a delicate, living optical instrument for concentrating rays of light on a sensitive, nervous surface. The principle of its structure is very similar to that of the photographic camera. Just as the lens of the camera focuses an image of a scene on the sensitive plate at the back of the darkened box, so the lens of the eye focuses an image on the sensitive nervous surface—the retina—that lines the hinder portion of the interior walls of the eyeball. These two portions—the lens and the retina—are the essential structures. The remaining parts are either protective, or are used for adjusting the eye to different ranges of work or to light of varying intensity.

Protective, Absorptive, and Sensitive Coats of the Eye.

The eye is spherical in shape, and its outer layer is a thick, tough, protective coat called the *sclerotic*. It is by means of this layer that the eye maintains its fixed shape, all the internal structures being more or less viscid or fluid. Except in front, where it bulges slightly and is transparent to admit light, the sclerotic is white and opaque. Attached to the inner side of the

sclerotic is a thinner coat, the *choroid*, carrying numerous blood-vessels to nourish the parts of the eye, and black with a dark pigment. Like the camera, the eye must have black interior surfaces to absorb scattered rays. Internal reflexion of light rays does not permit of the formation of

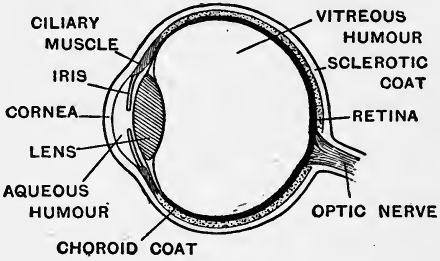

Fig. 25.

a clear, sharp, and distinct image. Within the second layer the fibres of the optic nerve, which enters the eyeball from behind, spread themselves out to form the sensory nervous surface which receives the impressions of light.

Refractive Media—the Lens, Aqueous Humour, and Vitreous Humour.

Immediately behind the cornea is fixed the lens, a transparent, double-convex, gelatinous body enclosed in a kind of bag, by which it is attached all round its edge to the interior wall of the eye-ball. Filling the remaining part of the interior of the eye-ball, supporting the lens in its place, and maintaining the spherical shape of the eye, is a transparent substance—jelly-like behind the lens and called the *vitreous humour*, more fluid in front and called the *aqueous humour*. Placed between the lens and the cornea is a kind of curtain, called the iris, circular in shape, with a central hole to admit light, called the pupil (see Fig. 25).

Looked at from the front the eye shows the central space, the pupil, black, because behind it is the dark pigmented inner lining of the eye. Through the pupil all rays of light must enter the eye. Round it is the variously coloured iris, a curtain capable of becoming larger or smaller according to the intensity of the light. External to the iris is the white of the eye, which is the front part of the opaque, tough integument, the sclerotic.

Movements of the Eye.

4. The sensory surface for receiving the light rays, the retina, is not equally sensitive over the whole of its area. In each eye there is one small part directly behind the pupil that is more perfectly discriminating to rays of light than any other portion. On this specially sensitive part are focussed the images of objects closely examined and definitely observed. It is obvious, then, that if the images of objects both near and far, to right and left, above and below, have severally to be focussed on the sensitive spot in each eye, the eyes must be capable of fairly wide and free movement in all directions. The axes of the eyes must converge on the object being examined wherever within the range of sight that object may be situated. In reading, for example, the axes of the eyes converge in succession upon each word as the eyes, turning from left to right, follow the print along the line. Then, as the eyes pass from line to line, they move downward, and the axes converge in succession upon the words in the next line.

Convergence of the Axes.

The eye-balls thus have considerable power of movement. They can move up or down, to right or left, or roll with a circular motion. By these movements the eyes can direct themselves on any object in front of them without the head being moved, or, when the head is moving, can keep themselves fixed on the object being examined. Moreover,

each eye moves in correlation with the other, so that the axes can be kept converged on the object wherever the object may be, or whatever be the relative motion of eyes and object. Clearly, when the object is near, the convergence of the axis is great, the eyes being pulled inward towards each other. When the object is distant, the convergence is small, the axes of the eyes being practically parallel.

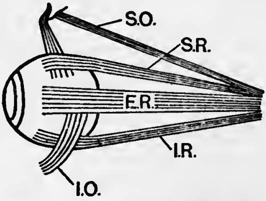

Fig. 26.—MUSCLES OF THE EYE. S.O., Superior Oblique; I.O., Inferior Oblique; S.R., Superior Rectus; I.R., Inferior Rectus; E.R., External Rectus.

The above movements of the eye-ball are carried out by six muscles which are attached to the exterior surface of the sclerotic on the one hand, and to the bony framework of the socket on the other. The above diagram (Fig. 26) shows the position of these muscles, and from it the possible movements of the eyeball are easily grasped.

Focussing Adjustment.

Before a definite and clear image can be obtained a further adjustment is necessary. In taking a photograph, in order to obtain a clear image, the distance from the lens to the sensitive plate has to be adjusted to the distance of the object from the camera. This adjustment the operator makes by moving the lens nearer to, or farther from, the plate. In the eye, however, the adjustment for distance is performed in a different manner. In forming an image of an object on the retina the rays of light from any point on the object diverge from the point to the eye, and are then turned out of their path by means of the refractive substances of the eye—the cornea, aqueous humour, the lens, and the vitreous humour. By this means the rays originally divergent are brought to a focus on one point of the retina.

The initial divergence of the rays clearly depends on the distance of the object from the eye. Rays from objects close to the eyes have considerable divergence; from distant objects the divergence of the rays is so little that the rays may be considered as parallel. Indeed, for all practical purposes, rays from objects over twenty feet distant may be treated as parallel.

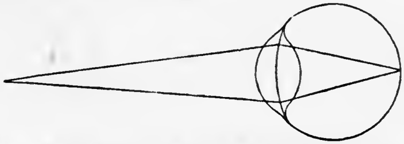

Fig. 27.—Normal Eye receiving Rays from Near Object and bringing them to a Focus on the Retina by increasing the Thickness of its Lens (accommodation).

Since the eye has to deal with both the divergent rays from near objects and the practically parallel rays from distant objects, it must possess the power of accommodating itself to distance. The refractive power of the eye must become greater as objects approach nearer than twenty feet. This necessary alteration in refractive power is secured by the lens changing its form, according to the distance of the objects being observed. By means of a small muscle inside the eye the enveloping integument of the lens can be relaxed or tightened. In this way the lens can alter its shape and obtain greater or less refractive power. In approaching an object which the eye is examining, the lens gradually becomes more and more convex in order to increase its refractive power so as to bring the increasingly divergent rays to a focus on the retina. There comes, however, a point where the lens reaches its utmost limit of convexity, beyond which it cannot go. Usually objects nearer than six inches to the eyes cannot be clearly imaged.

Types of Eyes.

5. The power of the eye to accommodate itself to distance depends, however, not only on the adjustability of the lens, but also on the shape of the eye, or, to speak more correctly, on the distance of the

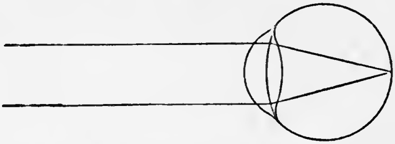

Fig. 28.—NORMAL EYE RECEIVING PARALLEL RAYS (FROM DISTANT OBJECTS) AND BRINGING THEM TO A FOCUS ON THE RETINA.

The Normal Eye.

lens from the specially sensitive area on the retina. In a normally perfect eye parallel rays—that is, rays from objects at a distance of more than twenty feet—can be focussed on the retina without accommodation. The lens in its relaxed state of least

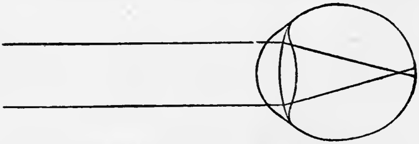

Fig. 29.—SHORT-SIGHTED EYE RECEIVING RAYS FROM DISTANT OBJECT. These rays are focussed in front of retina and so produce a blurred picture on the retina.

convexity has just sufficient converging power to form a clear image of such objects on the retina. Obviously, then, in the examination of objects nearer than twenty feet the lens must become increasingly convex.

Two defects of eye structure are thus possible. The eye may be more elongated or flatter than the normally shaped eye, and each of these shapes will lead to different kinds of defects of vision.

The Short-sighted Eye. In the elongated eye parallel rays are not focussed on the retina but in front of it, and hence a blurred indistinct image is formed on the retina. The lens for this shape of eye has evidently too great a refractive power. It cannot, however, become less convex. So, except by means of glasses of diverging power, distant objects cannot be seen distinctly. Nearer objects, however, can be focussed with ease, for the fault is a refractive power too great for the shape of the eye. Hence as objects get nearer the rays become more divergent and the lens becomes capable of focussing them on the retina without artificial aid. This kind of eye is known as the short-sighted eye. Without diverging glasses, objects at a greater distance than twenty feet are indistinctly seen. Nearer objects, however, are clearly imaged.

The Long-sighted Eye. In the eye of flatter shape than the normal parallel rays would, without accommodation, be focussed at a point behind the retina. Hence, to secure a distinct image the lens must obtain a greater refractive power by becoming more convex. Also the nearer the object comes to the eye the more convex must the lens become. Thus in this type of eye the lens has to adjust its shape to all distances great and small. Clearly, however, the nearer an object is brought to the eye the greater strain will be placed on the focussing muscle, until there finally comes a point beyond which further accommodation is impossible. The lens has reached its utmost limit of convexity. Objects nearer than this cannot be distinctly seen unless glasses which cause the rays to converge still further be used. This kind of eye is long-sighted. To see near objects requires greater strain than to see distant ones.

6. It is obvious from the above analysis that eyes which have become short-sighted from overwork have become

deformed in shape. They have become more elongated, so that distant objects cannot be focussed on the retina, and the shape of the eye has become adapted to near work only. When this result is induced it must evidently be due to forces acting on the eye when it is used constantly for near work. In examining an object near to the eyes, the eyes are pulled inward towards each other by muscles acting on the sclerotic coat. In childhood this coat is plastic. It has not yet hardened and stiffened into its adult form. Its shape is capable of being distorted by the stresses and strains produced by the muscles pulling the eyes inwards to converge the axes on near objects. From occasional strain, of course, recovery is easy. It is the continual and prolonged strain from hour to hour day after day during the years of growth that distorts the eye permanently, so that as the sclerotic gradually hardens the eye becomes incurably deformed into an elongated short-sighted eye.

Causes of Defects of Vision.

Use of Eyes in Near and Delicate Work.

The eye of childhood, unless distorted by overwork at near objects, is not naturally short-sighted but actually long-sighted. Its shape is flatter than the normal adult eye. This might be expected. Having to undergo strain in its plastic period of growth, the eye begins its life with a shape flatter than the normal eye, so that the strain of convergence incidental to ordinary eye work at varied distances will, by maturity, have reduced its shape to the normal. It is only when convergence on near objects becomes unduly prolonged and strenuous that an elongation beyond the normal is produced and permanent short sight results.

The deformity of short sight is, therefore, due to the plastic nature of the outer coating during childhood and youth. This coating gradually stiffens and hardens as the child grows older, so that the nearer the youth approaches

maturity the more capable is the sclerotic of resisting strain. Should the eye reach maturity without distortion its shape is then fixed permanently, and in all probability no deformity will show itself till old age brings weakness and decay. It is during the years of plasticity that damage is done by the eyes being used for near and delicate work, and the earlier in life such work is begun the greater is the probability of injury resulting. The time for using the eyes more continuously on near and fine work is when the sclerotic coat becomes harder than it is in early childhood. But it is not till adult life is reached that risk of deformity is reduced to a minimum.

Poor Health.

Other circumstances besides excessive and unsuitable work are conducive to deformity of the eyes. Every organ, as has been seen, is dependent for its strength and power on the general vitality of the organism. In states of general fatigue and weakness, bad nutrition and disease, the tissues of the eye, like all other tissues, suffer from the poverty and impurity of the blood stream. The muscles of the eye lose their strength and are more quickly fatigued, and headache, dizziness, and eye-spasm are frequently the result of even moderate exertion of the eyes. The protective coating becomes more flabby and less resistant, and the eyeball is thus more liable to distortion from prolonged convergence. It is, therefore, advisable that anaemic, badly nourished children, and children recovering from illness, should be relieved as much as possible from eye work of an exacting and near character.

Unhealthy Conditions of Work.

Conditions that promote general fatigue of the system are also injurious to eyesight. Breathing foul air, insufficient exercise, excessive mental work have their effects in weakening the tissues of the eye and thus rendering them more liable

to distortion under strain. On the other hand, good food, fresh air, and exercise strengthen the eyes.

Care needed during Periods of Rapid Growth.

Especially during the period of rapid growth is care needed in using the eyes. The body in growing rapidly makes great demands on the system, often greater than the blood stream can meet. Frequently weakness results, sometimes of a temporary character, though too often the injury is permanent. During this time of stress the seeds of nervous debility, digestive troubles, consumption, and anaemia, are planted in the system. Clearly, to meet rapid growth the body needs good nourishment, fresh air, exercise suitable in quantity and character, sleep, and periods of mental and bodily relaxation, while excessive mental and bodily work should be avoided. Fatigue is rapidly produced during this period, and may become a chronic condition. The eye, like all the other organs, suffers in the general debility. Eye fatigue, headache, and dizziness are very common among children at this period of life, and excessive study during this time may easily lead to permanent eye deformity.

Prevention of Eye Troubles.

7. The above examination into the cause of eye defects points out clearly the nature of the remedy. This, as in the case of general physical stagnation and the other physical deformities, should not simply be medicinal and curative, but preventive.

General Conditions of School Life.

The methods of school life must undergo a considerable change to bring them into harmony with the development of the child's physical nature. School life, we have throughout insisted, should be such that the pupils benefit in mind and body. School methods that bring weakness and deformity in their train cannot but be out of harmony

with the line of the child's natural development. Methods of learning should not weaken but strengthen, should not abuse but use wisely and well, the organs of sense and movement. Moreover, as has already been pointed out, the conditions of life injurious to one organ are detrimental to the full and broad development of all those other organs of sense and movement that have to work in correlation with it. A school life injurious to one organ is most likely too limited and restricted in its scope for the full development of both mental and bodily powers and is probably injurious to the general health.

The methods in general use at the present day err in forcing the child to use his eyes too often and for too long periods at delicate work at short ranges, and in compelling him to begin such work too early in life. The reforms suggested in the last chapter apply equally to the needs of the eye.

The school life should be organised so as to demand a wider and freer exercise of the bodily powers as a whole. The larger and stronger movements of the body and limbs should receive equal and earlier attention than the finer and more delicate movements of the hand and fingers. Limiting physical activity to the latter kind of movement restricts the use of the eye to near objects, and hence not only do the motor centres for the larger bodily movements remain insufficiently developed, but the eye tends to become distorted. On the other hand, the skilled practical activity that requires the use of the body and limbs in larger movements exercises the eye at longer ranges, and eye troubles do not result.

A school life, then, planned to develop fully and broadly the child's practical instincts and to train a wide variety of skilled actions, both the larger and the more delicate, will give a greater variety of scope to the work of the eye.

The eye will consequently tend to develop more on normal lines than it does under present conditions. Hence, games in the playground or playing-field, contests and exercises in the gymnasium, carving and handicraft in the workshop, practical measurements in and out of school, natural history, geographical and historical excursions to the country-side, free-arm drawing and arithmetical calculation at the blackboard, should be regularly interspersed among the reading, writing, arithmetic, drawing, and painting exercises that are done in the desks.

In the earlier life in the infant and junior schools the former type of lesson should be very frequent. The exercise of the eye on near objects and in doing fine work should come occasionally, but should not be of long duration. In the senior school a greater amount of desk work in writing, reading, drawing, and general study can be undertaken, though at no time during school life should the former type of school pursuit be discontinued. The larger movements of body and limbs should form an integral part of a child's and youth's education at every stage, not only because of their effect on general health, but because a full education requires that every variety of mental and bodily activity should have its place.

The change from a limited and narrow school life to one of a broader, freer, and more practical character would, as has already been pointed out, have its effect in promoting general health. This would strengthen the tissues of the eyes, just as the sedentary life of the class-room weakens them. Hence, if such practical work formed a part of the school pursuits, the closer study in the desks could be carried on more strenuously, because the eye and the body generally would be more resistant and have greater recuperative power.

Precautions against Eye Troubles.

Reading, writing, and other work requiring the eye to be used for fine work at a short range must make up some part of the school occupations. Indeed, the inclusion of such work would do no harm to the eyes or to the general health if it were performed under suitable conditions, and if work of a different character had its due place in the school life. Lessons requiring close use of the eyes should not be of great length, nor should two such lessons come together. It should be the aim of the teacher as far as possible to intersperse close eye work amongst the other pursuits of the day so that the eye is never used for any great length of time at delicate and fine work. Especially are such precautions needed in the infant and junior schools.

Lighting.

The class-room should be well lighted, so that there be no need for the pupils to peer closely at their work or to bend immediately over it. Lighting from the left hand is on all grounds to be preferred. Lighting from the front tends to dazzle the eyes, and that from behind casts a shadow over the work. Lighting from the right throws a shadow from the hand over the work and the rays fall too directly on the eyes, as the face is usually inclined slightly in that direction. To lighting from the left there are none of these objections.

The same principles should apply to artificial lighting. Educational authorities seem to be generally awake to the need of correct natural lighting, but forget all principles of lighting in the arrangements for artificial lighting. The artificial lights are generally placed over the heads of the pupils in the middle of the class, so as to glare in the eyes of those behind and to throw strong shadows on the work of those in nearly every other position. Dr. Kerr gives the following advice as to artificial lighting :—

"The position of the pendants in the existing class-rooms is rather with a view to symmetry than good lighting. There is often waste of light in some parts and poor light in other parts of the rooms. It is difficult to lay down definite rules, as each class-room has to be considered by itself.

"(i) Each class-room should be considered as being made up of two portions, the children's area and the teacher's area, and the lighting of these parts must be arranged independently.

"(ii) Left-hand lighting must be arranged for as far as possible, exactly as in the rules for window lighting.

"(iii) In calculating the area over which the rays of a lamp will extend, we must only take into our valuation those rays which proceed from lamps in front of the class to the back of the class. Lamps in front of a class illuminate to some degree the desks of the back row, but lamps to the back of a class do not help to illuminate the front rows of desks when the pupils are in their places.

"(iv) There must be a clearance of 6 feet 6 inches beneath pendants, and the luminous mantle must be as closely as possible approximated to this level; hence burners must be short, and cocks or bye-pass fittings must be placed on one side of the pendant arms, and not between burner and pendant.

"From suggestions (ii) and (iii) it will follow that the main desk-lighting will be arranged to come from the left and slightly in front of the child. The gas-fitter should mark the position of the first lamp to be hung over the centre of the first dual desk on the child's left of the front row. Proceeding, lamp positions should be marked out along this front row at from 6 feet to 9 feet intervals, according to the height of the desks from the floor; being

closer in infants' and further apart in the higher standards. The row of lamps thus marked out would give sufficient light for the front row and the second row of desks. A second row of lamps similarly spaced would light the third and fourth rows of desks. Since a lamp hung behind a child throws no light on the desk of that child, it follows that the space between the lamps from front to back of a room should be less than that between the lamps from side to side of the room."[1]

The lighting of the blackboard should be by means of a pendant or pendants placed in front of the board and on a level with the top. The light from these should be projected downward on to the board by means of an opaque reflector, which should also shade the light from the eyes of the pupils. Electric lighting is both cleaner and healthier than lighting by gas.

Arrangement of Work.

The desks, as has already been mentioned, should be such that bending and stooping over the work are hindered, and an upright carriage is promoted. The teacher should carefully watch for pupils stooping and persistently correct these faulty attitudes. Work should never be brought nearer to the eyes than twelve inches, and in reading the book should be held almost at arm's length. The print of the reading-books should be large and the words well spaced. Particularly is this necessary when young pupils are learning to read. In the early stages of learning every word and almost every letter has to be examined carefully. For similar reasons the size of writing and figuring during the period of learning should not be small,[2] and, as

[1] Report of the Education Committee of the London County Council submitting the report of the Medical Officer (Education) for the year ending 31st March, 1907.

[2] See Welton, *Principles of Teaching*, Chap. VII., § 2.

has been seen, this is also necessitated by the fact that larger movements with the arm and hand are made more easily than the smaller and more delicate ones of the hand and fingers. For children in the infant school the first years of writing and drawing should consist of blackboard work. The pupils should stand almost at arm's length from the blackboard and print or write the words with free movements from the shoulder, the letters being at least six inches high.

Eye-Testing.

8. Were school life and methods planned on the lines suggested above, eye troubles would be much less frequent than they now are. There would, of course, always be some children with abnormal eyes. Yet under proper conditions of school work the eye of childhood should become stronger and better, and should grow up into the normal eye. At present, however, custom and tradition, and to some extent want of opportunity, force too much close eye work on the pupils, and injury to the eyes is only too common. The teacher should, at any rate, endeavour to find out children who are suffering from eye troubles, so that the injury, if not beyond repair, may be remedied, or, if incurable, may not become worse.

Many of the signs of eye trouble are very obvious. Words written on the blackboard or maps hung in front of the class cannot be distinctly seen. Words begin to dance and blur after a few lines have been read. The eyes blink frequently or work is closely peered at with knitted eyebrows. Headache is frequent after continued reading or writing. The eyes are red and inflamed. These are all signs that indicate some kind of eye defect. The trouble, of course, may be only temporary, due to fatigue of the eye-muscles from overwork or induced by general ill-health or weakness.

More precise testing of all the children, however, is advisable, and is no very difficult or arduous matter. A class of forty can be roughly tested in half an hour, and, as far as the teacher is concerned, a rough test is all that is necessary. More accurate testing, in those cases where the teachers have discovered defects, should be left to the school doctor. The following method devised by Drs. Kaye and Lyster for use in the schools of the West Riding is very suitable.

The plan is founded on the principle that the normal eye can read with ease a certain size of type at 20 feet. As the distance increases, however, the laws of optics demand that the type, if it is to be read with equal ease, should become larger. At twice the distance the type should be four times the size, at half the distance one quarter the size. Twenty feet is taken as the distance for testing eye deficiency, because beyond this range rays of light from a point on an object to the eye may be considered as parallel. As the eye approaches nearer than twenty feet to the object the lens has to accommodate its refractive power to the distance.

The children are tested at twenty feet distance with two kinds of type—"20 ft." type and "40 ft." type. All the children should first be examined with the "40 ft." type at twenty feet distance. All who fail at this test are very defective, and are placed in Class C. Those who pass are now tested with the "20 ft." type at twenty feet distance. Those who fail here are moderately defective, and are placed in Class B. Those who pass both tests have good sight, and are placed in Class A.

All pupils should be examined in this way on admission and periodically every six months. A register should be kept of all the children to record the results of the examinations.

It must, however, be granted that finding out deficiencies, if followed by no attempt to alter the bad conditions that caused them, is quite worthless. Mere testing of eyesight

U T P V O

20 Type.

O L T B

40 Type.

is no remedy, and unless it lead to measures calculated to remove the causes of the trouble it is difficult to see what good is to be done by it.

CHAPTER XIII.

ABNORMALITIES.

Study of the Physical and Mental Condition of Children.

1. The course of physical training outlined in the foregoing chapters is intended for the child of normal physique and intelligence. There are, however, many children so poor in physique or so undeveloped intellectually that such a course, at least in its entirety, would be unsuitable for them. The defects from which children suffer may be due to accident, or to the conditions under which they have been reared, such as improper food, unhealthy surroundings, insufficient sleep, and a too early acquaintance with exhausting work. No doubt there are many children who inherit both mental and physical weaknesses, yet such innate tendencies can only be accentuated by bad conditions of life during the first few years of infancy. There seems to be among the poorer sections of our population a great ignorance concerning the rearing of infants. Babies are given improper food, and are taken about at all hours of the day and night. They are, for convenience, brought as early as possible to share in the family meal and the family life. Little consideration is given to the unsuitability of these to the tender constitutions of infants, who require special food and much sleep. Consequently rickets, scrofula, phthisis, nervous exhaustion, and mental weakness, if not positive idiocy, are common among those that survive the treatment.

Many defective children are so little removed from the normal that it would be unwise to give them special treatment in special schools. Such are the anaemic, and those suffering from heart weakness and nervous exhaustion. These children need treatment not of a different character from that of the ordinary child, but of a more relaxed and less strenuous nature. They can neither work nor play at the same pace as can the ordinary child. They soon become fatigued, and prolonged work and vigorous play bring on exhaustion which only accentuates the diseases from which they suffer. There are others, however, who have such marked mental deficiencies or require such special and individual treatment that they are best educated in special schools by teachers who have knowledge of their weakness and the mode of dealing with it. The consumptive, the epileptic, the blind, the deaf, the dumb, and the pronouncedly intellectually and morally defective come within this category.

Great care should be taken in selecting children for special schools, as much harm may be done by needlessly removing pupils from normal to abnormal conditions of life. One of the most important factors in the development of the child in school is the social life among his companions. Its influence on the development of character and intelligence can hardly be overestimated. The tone of the child's moral, intellectual, and physical life is strung up to the pitch of that of his school companions. Hence, to remove a normal child from the healthy, active, intelligent, and keen social work and play of the ordinary school, from its strenuous competitive and co-operative life, and to place him in the abnormal society of the mentally defective or the physically feeble is to cripple, hamper, and confine his intellectual, moral, and physical development. It is, therefore, only when the need for special treatment becomes

urgent that the extreme step should be taken. So long as their physical, intellectual, and moral deficiencies do not make these unfortunate children outcasts from the work and play of their more fortunate brothers and sisters, or so long as their physical or moral condition does not make them a danger to their companions, as in the case of consumptives and the morally defective, they should be allowed to mix freely and naturally with the others in the class-room and playground life of the school; care always being taken that they are not pressed beyond their strength in any form of competition. Children, like the beasts of the field, have a strong and innate aversion to weakness. The wolf-pack casts out or tears to pieces the weak and feeble, and the average boy, with a similar instinct, pursues with merciless contempt, ridicule, and persecution those who from physical or mental defects can enter but feebly into the boy-life of playground and street. Any children, therefore, who from infirmity would be likely to suffer bad treatment from their fellows, or who could not gain some benefit from the social life of the school, are better removed to special schools and educated in an environment specially adapted to their condition.

The selection of children for special schools or for modified treatment should be made by a duly qualified medical man after consultation with the teachers and parents. Only the specialist in children's diseases and weaknesses can say what the defect is, whether it is a temporary or permanent weakness, and what the course of medical treatment should be. The class teacher, however, can be a great help to the school doctor. It requires but little special training to take regular measurements of the height, weight, and chest capacity of the children, to test eyesight, and roughly to classify the children as good, moderate, or bad in these respects.

Further, the class teacher would have little difficulty in noticing the more obvious signs of anaemia, such as pallor, listlessness, and breathlessness after exertion; those of heart weakness, as breathlessness after exertion and blueness of the lips and finger nails, which may be present apart from cold; the open mouth and vacant expression that indicate adenoid growths in the pharynx; and the irregular purposeless movements of St. Vitus' dance. He would be able to notice the early signs of other diseases, as glands in the neck, deformities, awkwardness in gait, paralysis, and signs of infectious diseases. The class teacher has the child under longer and more continuous observation than has the school doctor, and consequently has more opportunities of noticing exhaustion following mental effort and physical exertion. Above all, he has special opportunities for detecting moral and mental deficiencies. The child's movements, modes of sitting, standing, and walking, his answers to questions, his degree of hesitancy and nervousness, his conduct in the playground, and his bearing to his companions can be constantly and continuously observed by the class teacher, and a little special knowledge and training will soon make the teacher quite competent to classify roughly the pupils as normal, slightly below normal, or requiring special examination. The latter should be carefully examined by the school doctor.

There are, moreover, occasions when the teacher has to act without delay. When symptoms of infectious disease show themselves in a pupil attending school prompt exclusion is the only safe course. A teacher ignorant of the signs of disease, or unobservant, may allow an infectious disease to spread among the children of the school when prompt measures might have stamped it out at the outset. Accidents, too, are not infrequent. Cuts,

bruises, even burns and broken limbs, are known in schools, and immediate treatment by the teacher may bring considerable relief and perhaps avert serious consequences. Where swimming is practised the teacher in charge of the pupils should have a thoroughly practical knowledge of life saving and the modes of promoting artificial respiration. There are, thus, many good reasons why a teacher should have a good practical working knowledge of children's diseases and of the way to deal with accidents likely to occur in school.

The teacher's work, then, is mainly confined to a rough examination of the children, to dealing with cases requiring immediate attention, and to recording signs of physical, intellectual, and moral abnormalities that come under his notice, and for which he should carefully watch. Serious cases should always be brought under the immediate notice of the school doctor. The school doctor should be something more than a general medical practitioner or officer of health. He should have a knowledge of child life and growth in all its aspects—intellectual, social, and moral, as well as physical. The great danger is that his interests, knowledge, and outlook may be confined to the body and its diseases. He should regard the child as a human being with character and intelligence, and whose body is an instrument in the service of mind. He should, therefore, base his advice and treatment on the principles of child growth as a whole, and view physical education not only from the standpoint of hygiene and medicine but also from that of intellectual, social, and moral development. Education should not neglect the hygienic view of school life, but that view is not the only one. Just as conduct has its physical, intellectual, moral, social, and aesthetic aspects, so a true education is the harmonious application of many sets of principles corresponding with these aspects.

Artificial, abstract, and barren if based on one only, school life becomes real, living, generous, and fruitful to body and mind when it combines all in harmonious proportions.

Thus, while we require in the teacher a knowledge of hygiene and of children's defects and diseases, we require in the school doctor a knowledge of the development of character and intelligence, so that in recommending treatment for the body the human aspect of school life will not be overlooked. Too many of the recommendations of doctors with regard to school life err in being too narrowly physical. A medical man, limited to the exclusively hygienic standpoint, sees a physical evil and often desires to apply the immediate and most obvious physical remedy, regardless of the general education of the child and of the effects of his treatment on character and intelligence. Thus, doctors frequently recommend formal physical exercises, and think little of the unfruitfulness of these measures in developing spirit and intelligence. It has been our aim throughout this work to keep in view the child as a whole, to consider him as a human being with mind and body in definite relations to each other. Physical education we have regarded not so much as one part, or even branch, of education, but rather as that aspect of the child's general education that will lead him into fuller and better relations with the practical life of the world, in which intelligence and spirit are of equal, if not of greater, importance than skill and physique. It is such a wide and generous view we look to the school doctor to take. He must regard the school less as a laboratory for hygienic experiment and more as a place where the child has to learn to live, and in which his powers of mind and body are acting in correlation in the mastering of his environment.

Mentally and Physically Defective Children.

2. The school, then, though organised in the main for a child of normal physique and intelligence, must be sufficiently elastic to meet the needs of those mentally and physically defective children that can gain some benefit from its physical and mental life. The teacher will thus require to study his pupils carefully, and not only to take regular measurements of height, weight, chest capacity, and eyesight, but also to note at all times any departure from the normal in power of attention, in bodily attitudes, in speech and movements, and in general conduct and appearance.

Signs of Mental Deficiency.

The development and vigour of the brain, of course, cannot be examined directly, but its condition can be fairly accurately inferred from the many physical evidences of brain activity. Brain action is best studied in the speech, voluntary actions, gestures, and facial expression of the child. In the child's speech, in his answers to questions, in his conversation, in his mental attitude in oral lessons, in his dealings with his companions in the playground are seen his powers of initiative, of persistent attention, of judgment, and of memory. A child of low mental development lacks power of attention, and consequently the impressions that come pouring in from the external world are but passing and fleeting shadows that come and go. The response to such impressions, or to the representation of them in memory and imagination, is but feeble, and hence he lacks initiative and intelligence, and shows himself mainly imitative in his conduct. Moreover, he is slavishly imitative, and cannot adapt the suggestions he gets to the needs of his own particular circumstances. He is slow in thought, and his conclusions are frequently arrived at through chance and haphazard suggestions in

sound or in appearance rather than through a grasp of essential likeness. He is incapable of prolonged attention. His eye wanders restlessly from one object to another, and he seems to have some difficulty in fixing his gaze definitely on one point. He sits as a rule stolidly indifferent, and when induced to make an effort his wrinkled and creased forehead and scowling face indicate the nature of the task to him.

The character of the child's movements is a good indication of brain development. During infancy the motor and sensory centres are not fully developed and do not work in perfect harmony with each other. The movements of the hand in extending to grasp an object cannot be fully controlled by the perceptions of sight, touch, and muscular movement. The infant, too, makes many irresponsible and irregular movements with apparently no object and not directed by perceptions of any kind, because the associations between the incoming sensory impressions and the outgoing motor impulses are not yet definitely made, as they are in the more fully developed brain. As the brain centres develop by means of a well-balanced education the sensory and motor centres are brought into more harmonious correlation. Irresponsible, irregular, and objectless movements are then inhibited. Control over actions is acquired and the movements are guided to their end by definite perceptions of sight, sound, and touch.

Control over movement—by which is meant the power to inhibit undesirable movements and to guide action by perception—is, then, a sign of good brain development, and want of control an indication of under-developed brain correlation. Under-development shows itself in imperfect inhibition. In the child of weak mind such movements as twitching of the hand and arm, irregular movements of the facial muscles, head, tongue, and eyes, and similar

movements of the body and limbs generally are very common. Especially are such movements likely to be made during times of emotional and intellectual stress, as, for example, when the child is being taxed with a fault or is making an effort to overcome some intellectual difficulty. In watching actions, too, such children seem lacking in the power to fix their eyes definitely on the action being performed and to follow it continuously from beginning to end. Their eyes shift restlessly from object to object. In seeing actions performed they unconsciously make the same movements, seemingly unable to inhibit or control the imitative motor response. Thus if a person nods or shakes his head they unconsciously follow suit. In imitating complex actions their movements are slow and awkward, showing imperfect correlation of the motor and sensory centres.

Aphasia and Agraphia.

Speaking and writing—especially speaking—are of all actions the most significant of the condition of the brain. Speech is produced by muscular movements of the vocal organs controlled from a motor centre situated in the motor area that controls the movements of the face. The motor area for speech is confined to the left hemisphere of the cerebrum, though the more general movements of the face are governed from both left and right hemispheres.

Since speech contains auditory, visual, and motor elements several nerve centres are concerned. These centres enter into all definite and controlled mental life. Impressions from objects in the external world reach the sense organs and are there converted into nervous impulses which are transmitted along the sensory nerve tracks to the brain. Each sense organ transmits its impulses to a definite sensory area in the cerebrum—the visual, auditory, olfactory, tactual area as the case may be.

The mental impression that results, however, is much more complex than that of a mere sensation of sight or sound. The impression has to be interpreted, given a meaning, received into the mental content, and brought into relation with other experience. A rose is not seen as a rose unless it stirs into activity other elements of experience of sight, smell, touch, and movement that will lead one to act towards it as one usually acts towards roses, to anticipate its smell, to know how to pluck it, and to name it as a rose. An object seen, then, must by means of the associative pathways of the brain awaken into activity many other parts of the brain than the visual centre before the complex mental act of understanding an object takes place.

Into the rational understanding of impressions speech almost always enters. Indeed, speech is so intimately connected with thought, feeling, and voluntary action of all kinds that it has a position of importance in mental life far above other kinds of action. We think by the help of words. Some people at times say the words aloud; others move their lips, but utter no sounds; others say the words to themselves, but utter no sounds and make no movements. Their thinking is done by internal speech, and this is the way most people of developed intellect work out their thoughts. Internal speech is the memory of words uttered; in it there is a distinct motor element—a memory of how the sounds are made, and a distinct auditory element—a memory of the sounds themselves. In some cases there also enters a memory of the words as seen. In reading and writing the visual element is prominent, and into the latter of these a motor element (hand and arm movement) is also present. There are thus several centres directly connected with speech—the motor centres for speech and writing, and the auditory and visual speech centres.

The speech centres besides having to function in correlation with each other in speaking, reading, and writing have to be in intimate and definite association with all parts of the brain; for actions, sensory impressions, and ideas are all thought about by language, and words seen or heard are only understood by means of the connexion of the speech centres with the other centres of the brain. The speech centres are then marked out above all others as centres with which every other cerebral centre, motor and sensory, must work in harmonious correlation. Imperfect development, injury to the brain, ill-health, and brain exhaustion are almost certain to be reflected in some disorder of speech or writing.

The injury or weakness may occur in the speech centres themselves, in the connexions between the speech centres, or in the connexions between them and the other sensory and motor centres of the brain. Hence speech disorders, known as *aphasia*, may be of very various characters, and range from slightly disordered speech to inability to understand speech or to utter coherent sounds. If the motor speech centre be affected the power to utter intelligible sounds is lost or injured, though other kinds of control over the vocal organs may be unimpaired. The person, though unable to speak, "can laugh and cry and even sing; but he either is unable to utter any sounds at all; or a few meaningless stock phrases form his only speech; or else he speaks incoherently and confusedly, mispronouncing, misplacing, and misusing his words in various degrees. Sometimes his speech is a mere broth of unintelligible syllables."[1] If the auditory speech centre be affected he cannot understand what is said to him, although he may be able to talk, to read, and to write. He suffers

[1] James, *Text-Book of Psychology*, pp. 108-109.

from 'word deafness'; though able to hear sounds they have no meaning to him. Similarly, if the visual centre be impaired 'word blindness' results, and he cannot read or understand objects seen, but can hear and talk and understand things heard and felt.

Though the motor speech centre is most directly connected with utterance, defect of any of the other speech centres, or injury to any of them, is likely to affect utterance. In speech, utterance is the last stage of a complex process in which meaning, sight, sound, and utterance are all closely bound up. In some cases the visual centre is the important intermediary between meaning and utterance, in others it is the auditory centre. Hence, if the visual or the auditory centre be injured or defective the utterance of words is disordered.

Disordered speech, then, is a symptom of brain condition of the greatest importance. The disorder may only be of a temporary character and due to brain exhaustion or illness, or it may be permanent and due either to defective development or to injury and disease. Pupils, then, who in their speech or in reading continually use words in a wrong sense, mix their words up, substitute words for each other, or have difficulty in recollecting well-known and familiar words should be carefully examined. If the speech defect is permanent it indicates a permanent defect of brain or vocal organs, if occurring occasionally it is probably due to exhaustion or illness. In the former case a medical examination is necessary; in the latter rest combined with nourishing food and recreative employment in the fresh air, will effect a cure.

Similarly, disorders in writing words, known as *agraphia*, indicate defective brain development or exhaustion. Extreme eccentricity in spelling should lead a teacher to suspect the presence of agraphia, and he should take the

first opportunity of drawing the attention of the school doctor to the case.

Intellectual and Emotional Expression.

The condition of the brain, besides being reflected in speech and action, shows itself in facial expression, gesture, and general attitude of the body. Mental states, by means of the centres of intellectual and emotional expression, cause movements in the muscles of the face and limbs, so that each state of attention and emotion has its own peculiar physical reaction. Strenuous effort, determination, patience, grief, joy, hatred, love are each associated with some characteristic facial expression, gesture, and attitude. It is through such physical forms that painters, sculptors, and actors exhibit to others the states of mind they wish to portray. So intimately related are the emotions with bodily movements that some psychologists deny the existence of emotions apart from the movements. "A disembodied human emotion," says Professor James, "is a sheer nonentity."[1] Stop the movement and the emotion ceases. The emotion is the sensation, the feeling of the bodily reactions aroused in face, limbs, and internal organs. However this may be, such signs of mental action are too valuable to be overlooked in studying the mental development of children. A face with heavy, dull, immobile, and unchanging features and expression plainly indicates want of brain action and feeble powers of intellect and emotion. On the other hand, mobile features, showing quickly-changing and various expressions, indicate good brain action and powers of intellect and feeling. Similarly, in general attitude and in gesture immobility indicates feeble mind, and mobility in attitude and gesture, combined with control and restraint, signifies a quick intelligence, power of attention and of inhibition.

[1] *Text-Book of Psychology*, p. 380.

It is only natural to expect, since the brain plays so great a part in stimulating and directing growth, that the development of the brain will show itself in some way in the bodily structure. Such indeed to some extent is true, although inferences from structure, unless confirmed by observations of the speech, movements, and behaviour of a pupil, should not be trusted. The most important structural indication of brain power is in the size and shape of the head. Though a large head does not always mean a large brain within, or a large brain a powerful intellect, yet in the main there is some connexion between size and shape of head and intelligence. Heads above or below the normal in size and different from the normal in shape indicate some fault in development. Especially in examining the head should the height, width, and slope of the forehead be noted. A narrow and receding forehead usually indicates a low mental type; a broad, high, vertical forehead a good mental type.

Structural Defects.

Indications in bodily structure that the animal nature in man is prominent are usually accompanied by low mental power and sensual traits of character. Thick lips, heavy and protruding lower jaw, thick, dull, heavy skin and flesh, usually, though not always, mean a low type of manhood or womanhood. Ears which stand out markedly, giving a wing-like appearance, with abnormal shape, are common among feeble-minded children, and a highly arched palate is often indicative of poor nervous development.

While the mentally defective child usually shows some or all of the above signs, it is not uncommon to find children as sharp as normal children, but who are morally defective, insomuch as they are addicted to thieving, deceit, lying, and indecent acts. The moral imbecile does not acquire the conscience which a normal child brought up in a healthy

school and home environment does. His moral instincts are either wanting or very feeble, and punishment and careful treatment have little effect on his actions or moral feelings. Cases of pronounced moral deficiency should be treated in special schools. Children suffering in this way should not be allowed to remain as centres of vile influence.

Treatment of Mentally Defective Children.

Pupils of feeble and undeveloped mental power should not have treatment of a markedly different character from that given to their more fortunate brethren; unless, indeed, the feebleness approaches idiocy. They will be dull and backward in their work, but punishment and isolation will not cure and are obviously unjust. They need every encouragement to bright, happy, energetic action, for it is only by action that their feeble natures will expand. Their intelligence will be appealed to mainly through such concrete and perceptual studies as natural history, practical measurements, various forms of manual exercises, and imaginative literature. Their powers of perception, of movement, of intelligence, of attention and control should be expanded and strengthened by a varied course of games, physical exercises, handicraft, nature study, and singing. Mixing freely with their quicker and more intellectual companions in active co-operation and competition they will expand in intelligence and power of will more than if they are kept at isolated studies or mix only with younger children or with children afflicted like themselves. It is, therefore, unwise to discourage such children by keeping them with younger pupils in the lower classes of the school. Even if unfit in many respects to proceed onward with pupils of about their own age, they will be more stimulated in such a class than if placed among pupils with whom they cannot mix freely and from whom they receive nothing

but contempt and ridicule. Self-respect is a virtue that underlies all conscious improvement, and more real effort is likely to be induced by encouraging self-respect than by punishment or degradation from the teacher and by persecution from companions.

Nervous Exhaustion.

Besides giving indications of brain development the conduct, movements, facial expression, and bodily attitudes exhibit the state of health and vitality of the brain. In an exhausted brain the power of inhibition and of guiding movements to a successful issue is not so great as in a brain that is fresh and well nourished. There is little power of spontaneous initiative. Hence irritability, nervous, irresponsible movements and gestures, combined with general immobility, listlessness, and drooping attitudes, are signs of nervous exhaustion. Movements become awkward and slow. The mind cannot be concentrated for long on one thing, and this is seen in the tendency for the eyes to wander aimlessly from object to object, and to look anywhere but where the teacher wishes the exhausted child to fix his gaze.

The inertness is physical as well as mental. The head droops, the body stoops, and the arms when held out tend to fall from the horizontal, and the fingers and thumb assume drooping attitudes. There is a tendency to pallor, with dark lines and fulness underneath the eyes. The facial expression during nervous exhaustion becomes less mobile. The face instead of being bright, with quickly changing and various expressions, becomes dull, heavy, and lifeless, and want of control may show itself in twitchings of the mouth and eyes. Similar irresponsible movements of the hand, such as clenching the hand and twitchings of the fingers, are also evidences of exhaustion. With a vigorous nervous system the head should be held erect,

the body upright, and the arms when held out in front should be in a position that indicates firmness and energy, with the fingers and thumbs straight and not drooping.

Pupils suffering from nervous exhaustion need careful consideration in their school life, and the amount and kind of mental study and physical exertion they are called on to do should be suited to their condition. They are incapable of strenuous mental or physical labour, and for this reason are often regarded as dull and unintellectual. They should not be pressed either at lessons or at games. They need relaxation, rest, and sleep. Their nervous vitality requires to be restored by good nourishment, fresh air, gentle exercise, and sunshine. They should spend as much time as possible in the open air at recreative pursuits of a gentle character, and should not be worried with either home lessons or examinations. Except in serious cases absence from school is not necessary. School life, if it be taken easily, gently, and without pressure and worry, will give occupation to the mind and body, and the fullest advantage should be taken of outdoor games, exercises, and excursions.

Deficient Vitality.

Want of physical vitality may be due to many causes, among which anaemia, weak heart, and improper food are the most common.

Anaemia.

Anaemia is a condition in which the oxygen-carrying capacity of the blood is diminished, and hence the oxygenation of the tissues is reduced. The vitality of the whole system is thereby affected, and nervous, muscular, and digestive troubles ensue. Anaemia is generally the result of disease, of badly ventilated rooms, of insufficient or improper food, or of insufficient sleep and outdoor exercise. One of its signs is pallor of the skin, which is best observed in the lips, finger nails, and gums. All the signs of nervous

exhaustion are also present, since the nervous system suffers with the rest of the body. The child is listless, languid, inert, and drooping. Physical exertion quickly brings on breathlessness, and mental effort is followed by fatigue.

Heart Weakness.

Heart weakness may be congenital or the result of illnesses such as rheumatic fever, scarlet fever, or measles. The circulation is sluggish, and this shows itself in deficient vitality, sometimes in an undersized body, thin features, and cold hands and feet, with, at times, blueness of the lips and finger nails. As in the case of anaemia, breathlessness quickly follows physical exertion, and the child seems incapable of any great mental or physical effort.

Children suffering from weak heart or anaemia should be under regular medical observation. They are unfit for strenuous work at school and should not be pressed or worried about their lessons. In the case of anaemia good nourishment and fresh air occupations should effect a cure, and in the case of heart weakness these will strengthen the heart. The greatest care, however, should be taken with children suffering from weak heart to adapt the physical exercises and games to their strength. They should never be allowed to exert themselves violently in lifting weights, climbing ladders, running, football, etc. Violent exertion will rapidly exhaust the heart and bring on serious consequences; gentle exercise, on the other hand, will strengthen.

Improper Feeding.

Improper and insufficient nourishment naturally results in deficient vitality, and all the tissues suffer. The physical frame is undersized and under weight, the features thin and puny, and the complexion pallid. Anaemia, nervous exhaustion, phthisis, and rickets frequently result from poor nourishment,

especially where there are other predisposing causes either in innate weakness or in unhealthy surroundings. Further, insufficient food has markedly deleterious effects on the mental condition of the child, and feebleness of intellect and moral instability frequently ensue.

Consumption.

Consumptive children require special treatment; the indoor life of the ordinary school and the home life in the poorer parts of our crowded towns are quite unsuited to their condition. As the disease, moreover, is infectious, the presence of consumptive children in school is a source of danger to the other children. The disease is due to the tubercle bacillus, or germ, finding a foothold in some part of the lung. The germs, multiplying and spreading, finally destroy the lung tissue. The germ has great powers of vitality, and exists in the air, in dust, and in dirt. Hence it is inhaled into the lungs with the breath. All people inhale these germs, but only those with some innate weakness of lungs suffer. The strong and vigorous easily resist the attack of the germs, and no harm results. It is obvious, however, that where the vitality of the lung tissue is reduced by poor nourishment, anaemia, or want of fresh air, or where the lung tissue is innately too feeble to resist the attacks of the bacilli of consumption, the disease gains a strong foothold and spreads. To overcome the disease the vitality and recuperative power of the lung tissue and of the system generally, and the nourishing and oxygenating power of the blood need to be increased, for it can only be fought and overcome by building up healthy vigorous tissue. Hence, good plain and nourishing food, fresh air, plenty of sleep, gentle recreative outdoor employment, with sunlight and bright happy surroundings, are the measures for combating consumption. Special sanatoria for consumptive children should be

provided, so that their life may be largely an open-air one. Their education should be suited to their condition, and open-air pursuits such as nature study, with drawing and painting, practical measurements, handicrafts, etc., should form a large part of it. Besides the lung, the tubercle bacillus may invade other parts of the body, and tuberculosis of the abdominal viscera and of the joints is not uncommon in children. The former early manifests itself in anaemia and lassitude. In the latter the teacher may often assist in an early recognition of the disease by calling attention to slight lameness occurring in a child without any apparent cause.

Rickets.

Rickets is very common among children in the poor districts of our large towns. Improper feeding and insanitary conditions of the homes during infancy seem to be the special determining causes. Excess of starchy foods and deficiency of fats in particular predispose to rickets. Thus, infants brought up on bread, biscuits, potatoes, with little fresh milk, together with want of fresh air and outdoor exercise, frequently develop rickets. The rickety child can easily be recognised by many obvious signs. "These are the square head; the beaded ribs; the narrow and constricted chest; curved spine and bent legs; enlarged wrists, ankles, or knees; knock-knee and flat foot; brittleness of bones, predisposing to fracture; general enfeeblement and pallor, and delayed development; and a marked liability to catch cold and acquire various diseases, particularly lung diseases."[1]

Results of bad feeding are due to home conditions, and hence all the school can do is to endeavour in some measure to counteract the effects. School life should be a free, active, and healthy one; many pursuits should be carried

[1] Lyster, *School Hygiene*, p. 228.

on in the open air; nature-study and geographical excursions into the country should be frequent; outdoor exercise and games should be regular; and the rooms should be well ventilated. The improvement of the mode of rearing infants is a most important social problem surrounded by many difficulties. The physical evil is apparent: it is want of proper nourishment and unhealthy conditions of life. The moral evil lies in the ignorance and indifference of the mothers. The question seems to be how to secure the proper rearing of children without violating the English traditions of personal liberty and independence and of parental responsibility. To sap the foundation of the English moral character by removing parental responsibility may do more moral and social harm than the injudicious provision of food may do physical good. What seems necessary is some process of education, by which is not meant mere instruction, that will reach the women of the nation at a time when parental responsibility will mean something. Instruction given to school girls is inadequate and from the nature of the case foredoomed to failure. The instruction falls on ears too immature to appreciate the importance of the problems, and is forgotten long before womanhood is reached. The instruction and training should be given to girls just as they are passing into womanhood, when the instincts of maternity are awakening and may be shaped by wise and judicious training into interests and habits of a rational kind.

Chorea.

The disease called *Chorea*, or St. Vitus' dance, occurs in children between six and fifteen years of age, and is most common among girls. It is primarily a disease of the nervous system, and is characterised by irregular, purposeless movements of the limbs and of the facial muscles. It is commonly associated with

rheumatism and is said to be excited by fright. The movements are jerky and involuntary, and are therefore to be distinguished from the uncontrolled voluntary movements indicative of mental deficiency. The disease requires medical treatment, and suspected cases should be reported to the school doctor.

Infectious Diseases.

3. A clear duty lies on teachers and education authorities with regard to infectious diseases. Although not directly concerned with the treatment of children suffering from an infectious complaint, they are distinctly concerned with taking measures to prevent its spread among the children attending school. Children suffer much more from infectious complaints than do adults, and although adults are by no means immune from attack, still the disease in them is of a much milder character and the mortality much less great. "In 1905 there were in England and Wales 11,076 deaths from measles. Of this number 10,383 were among children under five years of age. In the same year 8,482 children under five died from whooping-cough, while among those above five there were only 227 deaths."[1] These statistics plainly point to the conclusion that it is among very young children that infectious diseases are particularly disastrous. It is evident, then, that every endeavour should be made to prevent children, and especially young children, from becoming infected. Schools, where many children are congregated together, are, in particular, places favourable to the spread of disease, and especially so when the class-rooms are badly ventilated, ill-lighted, and dirty.[2] It is, without doubt, the duty of education authorities and of their representatives in the schools—the teachers—to exercise watchfulness in detecting pupils suffering from

[1] Jones, *School Hygiene*, p. 136.

[2] See Chapter IX., § 1.

infectious complaints, and by cleanliness and other means to prevent the spread of the disease to the other children under their care.

Source of Infection.

Infectious diseases are all due to the introduction of minute living organisms or poisons into the system. Living organisms, or germs as they are called, are found in the air, in the dust and dirt of the walls and floors of the rooms, in food and in liquids. They can thus pass into the system either in breathing or in eating. Many of the diseases of the throat, of which diphtheria is a type, consumption, catarrhs, and influenza, are caused by germs breathed in from the air. Others, like typhoid and scarlet fever, may be caused by germs taken into the system in water, milk, or food. Germs, too, may pass from an infected person either by the breath, or through personal contact, or by means of clothing, books, brushes, towels, and other articles used by him. From these considerations it is evident that there are two main ways of preventing the spread of infectious diseases in schools:—(1) by purifying and disinfecting the air, the rooms, walls, floors, desks, books, and apparatus of the schools; (2) by preventing communication between those known to have the disease, or suspected of being infected, and the other pupils.

Precautionary Measures.

The walls, floors, and desks of a school should be cleansed regularly with disinfectant solutions, and with special thoroughness on the outbreak of an infectious complaint. As has been seen, fresh air and sunlight are good purifiers, and the rooms of a school should be copiously flushed with fresh air from open windows and doors every day before the scholars enter and after they leave. The books, pens, and pencils in use should also receive particular attention. The rapid spread of some diseases can be directly traced

to these articles being used in common by every member of a class. It would be far cleaner and safer if every child had his own book, pen, pencil, towel, and place in the class-room, and was forbidden to use any other. If a child then became infected, his books, etc., could be removed and either destroyed or disinfected. One great channel for the spread of disease would in that way be removed. The circle of suspected pupils, too, would be narrowed. The child's intimate companions and those sitting in proximity could easily be removed and kept under observation.

Detection of Infectious Disease.

In preventing the communication of a disease from pupil to pupil it is important to be able to detect its symptoms at the earliest possible moment. Unfortunately in most cases of infectious complaints the disease does not show itself in a pronounced form until some time after the person has become infected. A pupil seemingly in good health, although in the initial stages of an infectious complaint, may thus be attending school and be a centre of infection. It happens, too, in some cases that a pupil is affected so slightly that, although feeling a little unwell, he still attends school throughout the various stages of the illness, and no one is aware that he is a danger to others. Thus, pupils with scarlet fever may pass unnoticed until the peeling of the skin or a discharge from the nose or ears indicates that they have reached the convalescent stage of the illness. It sometimes happens, too, that children may be carriers of the disease though not suffering from it themselves. This is especially so in diphtheria. Many children may be harbouring the germs of diphtheria in the membranes of the throat and nose and yet be resisting the attack of the disease. Though immune themselves they are thus

Difficulty of Detection.

capable of infecting others by means of slates, pens, and pencils. Such cases can only be discovered by a bacteriological examination of the material from the throats of all the children in a school. The prevalence of such cases is, too, a strong reason for banishing slates from school as unhealthy and unclean, and for insisting on each child using his own particular pen, pencil, book, and towel.

Period of Incubation.

The germs or poisons on entering the system live on the tissues or in the blood. There they multiply with great rapidity. At first they are, so to speak, fighting for their existence with the natural defences of the body. In the struggle one or the other may conquer. If the natural defences of the body prevail, then the person escapes the disease; if the disease germs or poisons conquer, then these, multiplying in the blood and tissues, produce there a condition which is the immediate cause of the disease and its symptoms.

The initial period of incubation, as it is called, may be long or short, varying in the case of each disease and with individuals. In scarlet fever it is short, rarely lasting more than three days; in measles it is long, and may be as much as eighteen days; in mumps it may be as long as twenty-one or even twenty-eight days. Once, however, the germs have established themselves in the system and have begun to multiply, premonitory signs of illness begin to show themselves, at first to the sufferer himself. He begins to feel listless, languid, drowsy, and generally out of sorts, although nothing of a pronounced character is evident either to himself or to onlookers.

Signs of Illness.

The second stage of the illness is reached when the disease definitely declares itself. The symptoms may appear quite suddenly or may come on gradually. The sufferer usually begins to have shivering fits, headache, and pains in the

limbs and joints. The skin feels hot, dry, and feverish. The pulse is quick and the temperature high. Sickness, nausea, and vomiting may be present, especially so with scarlet fever. In some diseases the throat and nasal channels are specially affected. Thus, in scarlet fever and diphtheria there is sore throat; in measles, German measles, and whooping-cough there are sneezing and running at the nose as if the person was suffering from a cold in the head.

As the disease progresses a rash usually appears. It may break out on the hands, arms, neck, face, body, or legs. In each disease there is a particular form of rash and a particular part of the body affected, so that an infectious disease can be frequently diagnosed by the appearance and position of the rash.

A teacher, then, should be watchful for any of the common signs of infectious diseases, and be specially observant of the appearance of the children when an infectious complaint is prevalent. The teacher should be suspicious of such signs as nausea, sore throat, and running at the nose. These, if combined with headache, a dry, hot skin, and a quick pulse, point to a possible case of infectious illness. Pupils suspected of having an infectious complaint should be immediately sent home and the school doctor informed at once. Those pupils who have been in close companionship with the ailing pupils should also be sent home and kept under observation until they either develop the disease or are found to be completely immune from it.

Closing the School.

Closing the school during an outbreak of infectious disease should not be resorted to unless there is clear evidence that such a course is likely to prevent the spread of the complaint. If the school is closed the opportunities for discovering

infected pupils, and of marking suspected cases, are considerably reduced. It is doubtful, too, whether the free mixing of children at play in the streets and recreation grounds will not be a more fruitful means of spreading the disease than their more disciplined congregation in school. Many of the children, also, are not likely to catch the disease, since one attack, especially if a severe one, usually renders a person immune from further attacks. It would, therefore, be well to know the history of each pupil with respect to infectious diseases. The possibility of the disease spreading wholesale throughout the pupils of a school could then be easily estimated. The disease is only likely to spread to those who have not already had the complaint. It might, therefore, happen in the case of a common complaint, like scarlet fever or whooping-cough, that only a small percentage of the pupils, especially in the senior part of the upper school, was liable to attack. A record should, therefore, be kept of the infectious complaints each child has had, and the question of the closing of the school should be decided in each case in relation to the extent of the outbreak, to the number of pupils liable to attack, and to whether the department is the infant, junior, or senior part of the school.

Special care is necessary in allowing pupils to return after an illness. In no case should a pupil be permitted to return without the medical officer certifying that he is free from the disease, and the sanitary authorities certifying that the house, with the clothing, etc., has been thoroughly disinfected. Even then in some cases there is danger. In the case of scarlet fever discharges from the ears or nose may occur after the pupil has been certified as free from infection, and such discharges are highly infectious.

When the fever has subsided, the temperature become

normal, and the rash disappeared, the stage of convalescence is reached. The vitality of the system, which has been reduced by the fever and high temperature, now requires to be restored by good nourishment, fresh air, rest, and sleep. Care should be taken that the system is not brought to the point of exhaustion by premature physical or mental exertion. Recreative pursuits, either physical or mental, are good when the child is well on the high road to complete recovery, but fatigue must be guarded against.

Many infectious diseases seem to be attended by special troubles of a local character. For example, inflammation of the ear is very common after scarlet fever and measles, and deafness may result. Brain affections and heart and lung troubles frequently occur after influenza. The great mortality among those suffering from measles is not so much due to the disease itself as to the attendant or consequent troubles, such as broncho-pneumonia and tuberculosis of the lungs. After an epidemic, therefore, persistent coughing by a child, exceptional pallor or languor, and deafness should be reported to the school doctor.

The following table is given in order that teachers may know the premonitory signs of the infectious diseases common among children, and the length of time required to complete a cure and for the isolation of a suspected case. It will be noted that the period of incubation varies considerably in the case of different diseases and also in different instances of the same disease. It is wise, therefore, to forbid the attendance at school of those children who are suspected of being infected for a period longer even than the maximum period given. It will be seen, too, that affections of the throat are common to many of the diseases, and that the mode of spreading the disease in almost all cases is either by the breath or by discharges from the throat and nose.

TABLE OF INFECTIOUS DISEASES.

Disease.	Signs or Symptoms.	Incubation, from exposure to first sign of Disease. (Days.)	Day of definite illness on which Rash appears.	Mode of Infection.	Period of Exclusion from School.	Quarantine Period.
SCARLET FEVER	Headache, shivering, vomiting, sore throat and hot dry skin; 2nd day, bright red rash; skin peeling follows, and later on discharges often occur from the nose and ears. Face very pale in later stages.	1—7	1st or 2nd	Discharges from throat, nose, and ear. Peeling of skin?	Till peeling has quite finished, and discharges from nose or ears have ceased (generally not less than six weeks).	12 days.
MEASLES ..	Begins like a cold in the head; with feverishness, shivering, running from the nose and eyes, and sneezing; blotchy rash about 4th day on the face, which looks swollen and heavy.	7—14	4th or 5th	Discharges from lungs, throat, nose and ear. Peeling of skin.	Till cough and discharges have ceased, and the skin is smooth; not less than four weeks.	18 days.
GERMAN MEASLES	Like both Measles and Scarlet Fever, but generally mild. Sneezing, blotchy rash, enlarged glands.	10—14	1st to 3rd	Breath (*i.e.* throat discharges).	Three weeks.	18 days.
DIPHTHERIA..	Sore throat, with lassitude and weakness as a rule; white points or patches on the back and sides of the throat; stiffness of neck; pallor. Sometimes merely like a mild sore throat.	1—8	No rash	Discharges from throat, nose, and ear.	Till two successive examinations for diphtheria bacilli have given negative results.	Till bacilli are proved absent.
WHOOPING COUGH	Begins like a common cold, followed in a few days by fits of coughing, which gradually develop the charactersitic long-drawn whoop, and are often followed by vomiting.	7—14	No rash	Breath (*i.e.* discharges from lung).	Till cough and vomiting have ceased. Two months at least.	18 days.
MUMPS ..	Pain and stiffness in jaws, feverishness and limb pains; swelling in front of ears and under the jaws. May be on one side only.	7—21	No rash	Breath (*i.e.* discharges from parotid glands	Four weeks.	21 days.
CHICKEN POX	Scarcely any preliminary illness; small red spots changing in about 24 hours to blisters (vesicles) containing clear fluid; these burst and form scabs. Spots at different stages of development.	10—14	1st—3rd	Breath and scabs.	Till all scabs have fallen off and skin is clear.	18 days.
SMALL-POX ..	More severe than last; headache, backache, vomiting, with rash similar to last; vesicles become pustules, then scabs on forehead, face, and hands.	12	3rd	Breath and scabs.	Till all scabs have fallen off and skin is clear.	14 days.

4. Accidents of a simple nature like cuts and bruises are sure to be of common occurrence in a school where games are regularly practised, while those of a more serious character like sprains, dislocations, and fractured limbs may be possible at times. The nature of the surface of the playground has much to do with the number and kind of accidents. Tumbles, with their consequent bruises and cuts, will be frequent on hard smooth concrete, and a surface of rough or even smooth gravel will cause nasty wounds on the skin and flesh, difficult to clean and slow to heal. The corners of the walls in the playground should be rounded off so as to diminish the risk of ugly wounds on the face and head. Whatever measures, however, are taken to lessen the risk of accidents, the high spirits and recklessness of a healthy boy will be sure at times to end in disaster. It is necessary, therefore, when accidents do occur that the teacher should be able to give 'first aid' in an efficient manner. The necessary appliances, such as bandages and lotions, should be ready at hand, and the teacher should be skilled in the use of them. Such skill can only be acquired by practical experience under the guidance of an instructor proficient in this kind of practical surgery. Merely reading of how to bind a wound, reduce a dislocation, and set a broken limb is of little avail when a disabled pupil is before you for definite treatment. Hence teachers, besides studying the general lines of surgical treatment, which is all that can be dealt with here, should attend an ambulance class for some time to gain practical skill in rendering 'first aid.'

Accidents.

It would be well, too, if the older pupils learnt how to deal with the simpler kinds of accidents. Many accidents occur during the dinner hour and after school-time when the teacher's help is not available. Many precious moments are at such times often lost by excited children rushing

about to find someone who can stop bleeding and bind a wound. The treatment of simple cuts and bruises is not beyond the skill of boys and girls of twelve, and the rendering of 'first aid' is a very valuable practical accomplishment in life. A practical course in 'first aid,' then, should form an adjunct to the physical training of the school.

In the treatment of all accidents it is necessary to act at once. Serious consequences may attend delay. The necessary appliances should be ready in a definite place and kept together in a 'first-aid' case. Lint, sponges, scissors, safety-pins, and carbolic solution should not have to be searched for. The teacher should be cool, calm, and collected, and proceed with his treatment in a deliberate and decided manner. There is always a certain amount of boyish excitement and girlish hysterics when an accident occurs, and a firm hand and a deliberate, cool, and smiling manner allay the excitement, subdue the hysterics, and soothe and encourage the sufferer. All but a few of the older children should be sent away at once. Those who are allowed to stay should be required to help, and should receive a practical lesson in 'first aid,' for it is only by helping in real accidents that the pupils will gain the confidence and resource required to deal with accidents by themselves.

Cuts and Bleeding Wounds.

When the skin is broken and blood is flowing the two essential things to aim at are (1) to stop the bleeding, (2) to keep the wound perfectly clean. In the case of a slight wound, when the blood is slowly oozing from capillaries or small veins and arteries, the wound should be well washed in cold water. Foreign bodies such as dirt and glass should be removed, and great care should be taken to see that no pieces are left in the wound. A piece of lint

soaked in a solution of carbolic acid (one part of acid to sixty of water) should then be placed on the wound and bound firmly in its place with a bandage. The bandage should not be so tight as to constrict the flesh and arrest circulation, or so loose that the lint can move.

Where the flesh is lacerated or the edges of the cut are widely separated, after cleaning the wound the flesh should be placed back in position or the edges brought together by small strips of plaster. The wound, however, should not be covered by the plaster. Spaces should be left for the wound to drain. The purpose of the plaster is simply to keep the edges together and not to heal.

When a large artery or vein has been severed the bleeding may be of a serious nature. A message should at once be sent to the nearest doctor by an intelligent pupil who can describe the nature of the accident. The doctor can then, without waste of time, bring the appliances he wants for immediate use. In the meantime measures must be taken to check the bleeding. Steady pressure of the thumbs on the wound should be applied until medical help arrives, or a bandage and pad are made. In the simpler cases it may be sufficient to tie a linen pad, soaked in cold water, firmly and tightly over the wound. If this does not check bleeding, stronger pressure to the artery or vein must be applied. In the case of an artery the pressure should be applied at a place between the wound and the heart; in the case of a vein, at a place on the side of the wound remote from the heart. Bleeding from an artery may be recognised by the bright scarlet colour of the blood, and by the blood gushing out in spurts corresponding with the beating of the pulse. The blood from a vein, on the contrary, is more purple in colour and flows steadily. If the wound is in the arm or leg the limb should be tightly constricted by

means of a tourniquet. This appliance is most quickly made by tying a knot in the middle of a folded handkerchief. The knot should then be placed over the artery or vein and the handkerchief tied by means of a *reef knot* round the limb. The pressure can be still further increased if necessary by passing a stick or pencil under the handkerchief and twisting it round and round. Bleeding from an artery can be further checked by bending the joint above the wound so as to constrict the artery at this point.

Dr. Lyster gives the following advice on dealing with such wounds:—"Bleeding from the palm of the hand may be stopped by pressing a pad upon the wound and tightly binding the fingers over it. Similarly, if from the forearm, place a pad in the fold of the elbow, bend the forearm on the arm, and tie it tightly bent. If from the arm, press a pad into the armpit and bind the arm to the side. In the same way bleeding from the foot may be stopped by direct pressure, while bending the leg upon a pad behind the knee will stop much of the bleeding below the knee. Bleeding from the face and head can usually be checked by pressure against the bony surface beneath."[1]

Bleeding from the nose is somewhat frequent in boys' schools, and is sometimes difficult to stop. The child should not bend his head over a basin, but should sit as still as possible in a chair and throw the head well back with the arms raised. The head, face, and neck should be freely sponged with cold water.

Bruises. When the skin is not broken and the bleeding goes on inside the skin a bruise is the result. Bathe immediately in as cold water as can be got in order to stop bleeding. Much of the discolouration that attends a healing bruise can be prevented by such

[1] Lyster, *School Hygiene*, p. 318.

immediate measures. To reduce swelling bathe in hot water.

Burns. Occasionally it happens that a child burns himself at a stove or fire, or during some school entertainment when excitement is high a child's dress may catch fire. In the latter case throw the child down so as to keep the flames from enveloping her and, wrapping a cloak or jacket tightly round the burning dress, roll her to and fro along the floor until the flames are extinguished. In the case of a serious burn send at once for a doctor, but in the meantime treat the burn in the following manner. Remove the clothing from the injured part by cutting it away. If any sticks to the flesh, leave it there by cutting all around it. The object now is to exclude the air from the surface of the burn. Cover the burn with lint soaked in linseed oil or olive oil, or in a saturated solution of bicarbonate of soda. The best preparation, however, is *carron oil*, a mixture of equal parts of lime water and olive or linseed oil, which preparation should be kept in all schools. Now wrap the whole in a thick sheet of cotton-wool or flannel, and keep in position by means of a light bandage. If the child is suffering from shock and inclined to faint, administer strong tea or coffee.

Fractures. Falls in the playground or down the school steps may result in a broken bone, which may be serious if the bone is forced through the flesh and skin. Bleeding and blood-poisoning are, then, factors that have to be guarded against. When a doctor can be got immediately it is better to lay the patient down, place the limb in an easy and supported attitude, and keep the child as motionless as possible. In country districts, however, it is often many hours before a doctor can be brought, and teachers in country schools should know how to set a broken limb.

A fractured limb may be recognised by the loss of power of movement, and by the unnatural position of the limb. There is also local swelling and pain, and the fracture may be felt and indeed heard when the limb is slightly moved.

In treating a broken bone the child should be kept absolutely motionless, and the affected part in as natural a position as possible. Clothing should be cut away, never pulled off. Bring the broken parts of the bone together by drawing steadily but gently on the limb and placing it in a natural position. Place padded splints along the limb and bind so that it cannot be moved. In fracture of the arm bind the arm to the body; in fracture of the leg bind both legs together; in fracture of the thigh bind round the body. When the collar-bone is broken a pad should be placed in the armpit and the arm put in a sling; then the arm bound to the body by means of a broad bandage.

Fainting, Epilepsy, and Hysteria.

Fainting, especially in hot weather and in badly ventilated rooms, is not an uncommon occurrence in schools. It is due to temporary heart weakness. The child is extremely pale, the skin cold and moist, the pulse feeble and slow, the breathing hardly perceptible. There are no convulsions as is often the case in epileptic seizures. The child should be laid flat on his back, and in a place where he can freely get fresh cool air. All tight clothing about the neck, chest, and waist should be loosened. Sponging the face with cold water or water and vinegar will assist restoration, and smelling salts may be applied to the nostrils. No attempt should be made to pour anything down the throat while the child is unconscious, although when he is recovering consciousness weak stimulants should be given in small doses.

An epileptic fit is a nervous complaint. It usually

occurs very suddenly, and in the severer cases is accompanied by convulsions. The child generally screams and falls down unconscious and rigid. Then follow convulsions, the hands are clenched, the limbs jerked to and fro, the patient becomes blue in the face and foams at the mouth, while the tongue is frequently bitten through. Nothing can be done except to prevent the patient injuring himself. Place him in the fresh air, loosen all tight clothing, raise the head slightly and support it on something soft, keep the body warm by wrapping in a cloak, and place something, such as a cork or piece of wood, between the teeth. When the convulsions cease allow the patient to go quietly to sleep.

Hysteria is another nervous complaint, common among emotional girls, and is attended by many symptoms showing great want of control and power of inhibition. Grinding the teeth, shouting, laughing, crying, screaming, stamping, are some of the indications that the emotional centres are uncontrolled by the centres of intelligence. Hysterical children should either be left alone and no notice taken of them or dealt with firmly and decidedly. Don't, under any circumstances, argue with, or appeal to, a hysterical child. Order her in a firm voice to desist, or send for a glass of water and dash it over the face. Leave the child to herself when she has recovered.

Drowning.

Swimming we have advocated as an exercise for all children, and the different forms of life-saving and of restoration of the apparently drowned should be known by the teacher and taught to the elder pupils. In cases of apparent drowning send at once for hot blankets in which to wrap the body of the child and hot bottles to apply to the feet. Loosen all clothing about the neck and chest, draw forward the tongue and keep it projecting by means of an elastic band

or string passed over the tongue and under the chin. Rub the chest and arms vigorously so as to promote circulation, and apply artificial respiration if the patient shows no signs of recovery.

In inducing respiration by artificial means the patient should be placed on his back with the head and shoulders supported on a firm cushion, which can be made by folding jackets. The operator should then kneel at the patient's head, and grasping his arms firmly below the elbow, pull them slowly and steadily upwards till they are above the head, and keep them stretched there for two or three seconds: this action raises the ribs and expands the chest, thus causing inspiration. To produce expiration reverse the action, bending the arms and pressing them forcibly against the walls of the chest. This action forces the air out of the lungs. These movements should be repeated alternately about fifteen times per minute until breathing becomes spontaneous.

When natural breathing begins proceed to encourage circulation and to warm the body. Rub the limbs vigorously upwards towards the trunk. Wrap the patient in warm blankets and apply hot flannels or bottles to the pit of the stomach, the feet, the legs, and armpits. Stimulants such as brandy or hot coffee should be given. When recovery is assured the patient should be placed in bed and induced to sleep.

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